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BLOCK ANESTHESIA AND ALLIED SUBJECTS

BLOCK ANESTHESIA
AND ALLIED SUBJECTS

WITH SPECIAL CHAPTERS ON THE MAXILLARY SINUS,
THE TONSILS, AND NEURALGIAS OF THE
NERVUS TRIGEMINUS

FOR
Oral Surgeons, Dentists, Laryngologists, Rhinologists,
Otologists, and Students

BY
ARTHUR E. SMITH, D.D.S., M.D.
ORAL SURGEON TO FRANCES WILLARD HOSPITAL AND TO HOUSE OF GOOD SHEPHERD,
CHICAGO

FIVE HUNDRED NINETY-FIVE ILLUSTRATIONS

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TO THE MEMORY OF
MY MOTHER

WHO IN LIFE WAS MY COMPANION, WHOSE LOVING SYMPATHETIC DEVOTION WAS MY UNFAILING INCENTIVE TO GREATER EFFORTS; WHOSE KINDNESS OF HEART WAS ALWAYS MY CONSTANT INSPIRATION, THIS VOLUME IS AFFECTIONATELY DEDICATED.

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ENDURING SUCCESS

"He has achieved success who has lived well, laughed often and loved much; who has gained the respect of intelligent men and the love of little children; who has filled his niche and accomplished his task; who has left the world better than he found it, whether by an improved poppy, a perfect poem or a rescued soul; who has never lacked appreciation of earth's beauty or failed to express it; who has always looked for the best in others, and given the best he had; whose life was an inspiration; whose memory a benediction."—*Bessie A. Stanley.*

PREFACE

It was while a senior in St. Louis University School of Dentistry, ten years ago, that I became vitally interested in anesthesia for the relief of pain during oral operations. As a student my instructors allowed me the privilege of employing nitrous oxid (with gasometer and face inhaler) for sensitive cavity preparation, etc. The gratitude expressed by the patients inspired me to greater effort. Realizing that my patients appreciated dental service free from pain, upon entering practice after graduation, a nitrous oxid-oxygen apparatus was a part of my initial equipment. Its use soon manifested its approval and appreciation from my patients. Here I wish to acknowledge my appreciation to Dr. Charles K. Teter for valuable instruction; also the Southwest Missouri District Dental Society, to Dr. Frank O. Hetrick, to Dr. J. P. Buckley and my brother Dr. C. A. Smith, for their valuable cooperation during my early career. I have often been asked how I became interested in this subject, and my object in making the above statements regarding my student and early professional experiences is to inspire the student who is about to enter upon his life work. As time went on I realized that one anesthetic agent would not suffice for all patients for oral and dental surgery, so I entered the field of local anesthesia and employed the method which was best adapted to the individual patient. After writing articles for our journals, many of my friends urged me to write a textbook, which was undertaken several years ago.

The advancement in the administration of anesthetics has undergone a steady evolution, being especially rapid during the past few years. The perfection of the nitrous oxid-oxygen apparatus and the development of synthetic local anesthetics have made the way possible for greater advancement. The perfection in technic of block anesthesia and general anesthesia, and the placing of the same upon a scientific basis has kept pace with the advancement of other phases of dentistry and medicine. The technic for the various phases of local anesthesia has developed to such an extent that practically all operations may be successfully performed under the block method.

By the block method, the pain resulting from the use of the knife, the crushing of the forceps, the cutting of sensitive tooth structure, is abolished. The leaders in surgery today are not satisfied with merely removing the sense of pain, but in addition they employ recognized methods for combating preoperative, operative, and postoperative complications. In most cases, patients who are in need of oral and dental surgery dread the dental chair. In many instances, they have delayed treatment which is so necessary for the proper maintenance of health until compelled to submit to operation, due to the ravages of decay.

The watchword of today in both dentistry and medicine is prophylaxis.

Our duty to humanity and to our profession is to prevent disease. In my opinion, fear of pain has been preeminent in causing the construction of many crowns, artificial dentures, and the treatment of many teeth, which could have been avoided by early attention.

The dignity of anesthesia and its progress have been advanced by such organizations as the American Society of Anesthetists, New York Society of Anesthetists, Interstate Association of Anesthetists, and the National Anesthesia Research Society. If the next ten years reveal as much as the past ten years, anesthesia will occupy a preeminent place in the scientific world, which it rightly deserves.

The extensive literature which has appeared in our journals and the interest displayed by the professions during the past few years, in both general and local anesthesia, attests a growing realization of the importance of ascertaining an accurate knowledge in the practical application of anesthetics.

The day has passed for inaccuracy in technic, for those who are students. Failures mean in most cases incompetency and inaccuracy in technic. Today the modern trend is to entrust the administration of general anesthetics to the specialist, and a large number of hospitals have a trained anesthetist on the hospital staff. Many of our leading medical and dental colleges, recognizing its importance, have established a chair of anesthesia and give instruction and practice in anesthetics. Until recently the surgeon did not consider anesthesia of much importance. The modern surgeon no longer regards the anesthetist as the least important factor in the performance of the operation, but fully realizes that, in many cases, the anesthetist's responsibility is as great as that of the operator himself, and there is a growing demand for the intelligent and skillful administration of the anesthetic. The operator who administers either a general or local anesthetic should have a knowledge of physical diagnosis, the therapeutic and toxic actions of anesthetic drugs, treatment of syncope, shock and collapse, etc.

The principal object in writing this book is to give in practical and utilizable form, the technic of block anesthesia and to include the important allied medical subjects, which are so closely interwoven, and the knowledge of which is so essential. This book has been written principally for oral surgeons, dentists, and students, and an endeavor has been made to discuss the subjects and give the technic step by step in a definite and thorough manner. As a special textbook it will be used by two classes of readers, one class consulting it for reference in connection with their cases; the other composed of practitioners and students who desire to familiarize themselves systematically with a knowledge of block anesthesia and the allied subjects. There is no royal road to mastering the technic, but if the student undertakes it in a proper and systematic way, it will be comparatively easy. The basis of block anesthesia and a knowledge of the allied subjects are essential. Therefore, in writing this text, various chapters on the allied medical subjects have been discussed. The technic for the various block injections is based upon anatomy and has been made as simple and practical as possible, being placed upon a scientific and accurate basis. The diagram on classification of the methods of local anesthesia, which appears on page 33, should give the reader a clear conception of how the subject is divided and subdivided.

It will be noted that the following general headings have been used for discussion of each deep block injection; topography of anatomy; needle employed; technic of injection; injection of solution; precautions; time to wait for anesthesia; structures anesthetized; blocking the interlacing or overlapping branches. This method will enable the busy practitioner to turn immediately to the desired subject and obtain the information without delay or without reading many pages in order to find what he desires.

The chapter on blocking for tonsillectomy, nasal wall and septum, will, no doubt, prove of value to the laryngologist and rhinologist because it is a departure from the methods used in the past. The chapters on tic douloureux and maxillary sinus include modern technic for blocking.

It will be seen that some repetition is evident, but the repetition of important facts is desirable in order to impress the reader.

The text contains 595 illustrations, most of which are original. The wet dissected anatomical specimens were prepared by the writer and have been used in this text to make clear the technic of injection.

An endeavor has been made to give due credit to all authors whose articles and books have been consulted, whenever it was possible to do so, especially with reference to establishing originality. If credit has not been given to any one, it is due to an inadvertence on the part of the author.

I wish to express my thanks to Dr. J. F. Corbett, Department of Experimental Surgery, University of Minnesota, and to Dr. Ira G. Nichols, for their valuable cooperation in the laboratory research and in the preparation of the illustrations appearing in Chapter XIX. I desire to thank Professor W. D. Zoethout, physiologist, Dr. George W. Funck, Professor C. A. Cary, and M. M. Burdick, chemists, for their guidance and assistance in research.

The writer takes this opportunity to tender his sincere thanks to Dr. C. N. Johnson for his valuable suggestions and guidance, and to William Whitford and Miss A. May Whitford for their efficient stenographic work and most generous and liberal assistance in classification, references, and numerous courtesies.

Great appreciation is expressed to Miss Mildred E. Conyes for her valuable stenographic work and in posing for many of the illustrations.

I wish to acknowledge the invaluable assistance received from my associate Dr. Howard C. Miller, and to Mr. Charles W. Warner in the correction of the manuscript and for many helpful suggestions.

I am indebted to Dr. Harris E. Santee for his valuable suggestions in arranging Chapter VI, "Classification of the Nervous System."

The author is indebted to the following for their valuable suggestions and cooperation: Drs. Vaughn L. Sheets, C. Victor Vignes, F. E. Roach, J. M. Prime, Charles F. Chandler, Jules J. Sarrazin, B. Boyd Bogle, Ewell Neil, L. S. Borland, Alfred deRoulet, William H. DeFord, Leigh F. Watson and Albert Worsham.

The writer wishes to thank the artists and photographers of the Pontiac Engraving Company, especially Messrs. Lewis Osborne, Oswald Ball, Edward G. Schwuchow, Josef Froula for their untiring and efficient services. My thanks are due to my publishers for their suggestions, helpfulness, and cheerful cooperation.

Finally, I extend thanks to all who have aided me in this undertaking, and I speak from the heart when I hope this volume will prove of value to suffering humanity and serve as a link in the chain of advancement of dental science.

ARTHUR E. SMITH.

Chicago, Ill.

FOREWORD

Ever since the beginning of man's record we find him shrinking from pain. One of the first principles the modern operator has to confront is adverse autosuggestion, which is early instilled into the mind of the child through the thoughtless chatter of adults who delight in giving graphic descriptions of the frightful experiences they have undergone during dental operations. Unless patients fall into the hands of some competent operator, who recognizes the importance of securing their confidence through reversing the law of redintegration and of associating dentist and pain, and by not causing them unusual pain and treating them as equals, it is likely to remain as a bugbear to rise up and minimize our most careful endeavor.

I would suggest to those who wish to know more of the working of the mind to read "The Law of Psychic Phenomena," Jelliffe's translation of Dubois' work, or Bernheim's "Suggestive Therapeutics." These books will be a great help in understanding what weight suggestion plays in every phase of analgesia and its wonder-working power, even when general anesthesia is used. On account of lack of time, it was with regret that I refrained from writing a chapter for this volume on the power of suggestion. The author, however, has emphasized the importance of it, but has not gone into minute detail of the best known methods of procedure to establish in the mind of the operator its fundamental principles.

The man who will get the most out of this volume, all it is intended to give, must pay careful attention to the details as outlined. In addition, he must have undaunted courage. This is not a book for the timid or for cowards. First, a man must be sure of mastery of himself and must be thoroughly familiar with all phases of this subject, as outlined on page 34 of this volume before he can hope to achieve success. To some, there may seem to be considerable repetition in the book, but to my mind there is only a desire upon the part of the author to firmly fix in the minds of his readers the necessity of complete mastery of a particular point.

The illustrations are beautiful and most helpful in illuminating the technic to obtain certain and uniform results. The author does not use the words "rifle versus shot gun methods," but his whole effort is to teach a delicate precision that goes directly to the point and produces results which inspire confidence in the mind of the patient. Thus half the battle is won.

It is worthy of note that the author specifically teaches that physical diagnosis is essential to determine which anesthetic is best for the particular case. The man who is looking for some quick method of mastering block anesthesia and allied subjects, that can be understood and applied without effort (in forty days) had better stop right here and read no further. If, on the other hand, he be one who is seeking for the best possible knowledge upon the subject of local anesthesia and allied medical subjects and is willing to spend his time in an earnest endeavor to acquire the highest he is capable of receiving, this volume will give him the last word (to date) and open fields filled with the golden grain of truth and fringed with the flowers of attainment. The reader will ever be conscious that he can improve upon his application of the technic as herein taught, and that he might know every word of the theory contained in this volume and not be able to exercise that delicate, precise, and forceful touch which is described as the goal to be sought. As an operator's mastery of the technic improves, he will find that he will gradually minimize the dosage rather than depend upon flooding the immediate area with two or more mils of the anesthetic solution.

The many references back and forth to the illustrations are helpful in fastening in the reader's mind some specific teaching point.

This volume will be a boon to the practitioners in small cities, towns, and country villages, who do not have access to an anesthetist or hospital facilities, but who have to perform about every operation incident to dental practice. They will always have at hand a friend with whom they can consult. They will find that each block injection has been discussed under specific headings, such as Topography of Anatomy, Needle Employed, Technic of Injection, Injection of Solution, Time to Wait for Anesthesia, Structures Anesthetized, Blocking the Interlacing or Overlapping Branches, etc. In separating subjects in this manner the reader does not find it necessary to read page after page of matter to find what he desires.

The author has been thorough in pointing out the indications and contraindications for the various methods of local anesthesia, and also the indications and contraindications for block anesthesia and general anesthesia. He has quoted many other authors and has given them full credit.

If you are determined to "Show thyself a workman approved unto God" —and may I add suffering humanity— go right ahead into the study of this subject and you will find answer to all your questions in this volume, and your patients will call you blessed.

Dr. Smith has burned the midnight oil and has made great sacrifices both in time and energy in the preparation of this volume, and knowing him as I do, he will feel abundantly repaid if it is as helpful to you as it has been to me.

It has been a keen delight to have had frequent conferences with the author during the building of this volume and to have discussed many of its salient features with him and to watch it grow.

FRANK O. HETRICK.

Ottawa, Kansas.

INTRODUCTION

He who reads this book will be more deeply impressed than he ever was before with the breadth and scope of local anesthesia. This science when measured by years is only in its infancy, and while much has been written concerning it, both in textbook form and in current literature, yet it has remained for Dr. Smith to amplify the subject in a way never before attempted. It would seem that he has outlined in detail the procedure in every possible combination of cases, and he has come more nearly leaving nothing unsaid upon the subject than any other writer with whom we are familiar.

His evident conviction that every step of the technic should be illustrated has been amply carried out through the book and this will prove to many one of the most instructive and attractive features of the work. So many original cuts are used that it amounts to practically a new creation in this feature of the subject. The time and energy devoted to the illustrative part of the book would prove a revelation to the average reader if it were at all possible to compute. It is a feast laid out, after careful planning and preparation, for the invited guest to fully enjoy.

An innovation in a work of this kind will be found in the treatment of such subjects as Oral Surgery and Exodontia, the author evidently having concluded, after mature thought, that the consideration of block anesthesia led so directly and intimately into these subjects that they could not well be excluded.

The profession owes much to the makers of our literature for their time and toil in elaborating and describing the various methods of practice in everyday use, and Dr. Smith has made it his debtor in a very unusual way by the immense amount of work he has devoted to the preparation of this volume. "It is a book that will eventually be found in the library of every man who practices local anesthesia, and the careful elaboration of each detail, together with the very proper cautions against mistakes, will make it possible for the practitioner to perform his work with greater safety and more assurance than he has ever done in the past."

C. N. Johnson.

Chicago, Ill.

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BLOCK ANESTHESIA AND ALLIED SUBJECTS

CHAPTER I

HISTORY OF ANESTHESIA

Among the great benefactors to suffering humanity are the discoverers of anesthesia, and those prominently identified with its discovery are Horace Wells and William T. G. Morton, dentists, and Crawford W. Long and Charles T. Jackson, physicians. To America belongs the credit and honor for this discovery. When an attempt is made to designate the particular individual who first discovered anesthesia, it is difficult to reach a decision as to whom the honor belongs; nevertheless, the names of the men mentioned are inseparably connected with its discovery.

Three Great Achievements.—The three great achievements which stand out as landmarks in the records of progress during the last century connected with the advancement of medical and dental science, have no parallels in the history of these two professions. These are anesthesia, antitoxin, and antisepsis.

Ethyl ether was first known as sulphuric ether and sweet oil of vitriol. This compound was known as early as the Thirteenth Century, but the name of its discoverer is unknown. During the Eighteenth Century it was used for medicinal purposes, but its narcotic properties had not been discovered until it was employed by William T. G. Morton, of Boston, Massachusetts, for surgical anesthesia in the year 1842. Morton demonstrated its value in a public way in the surgical clinic of Warren at the Massachusetts General Hospital, October 16, 1846.

The four men associated with the discovery of chloroform, are: Guthrie, of Sackett's Harbor, New York, who is given the credit, according to literature, for its first discovery in the year 1831. Soubeiran, of France, and Liebig, of Germany, were close contemporaries with Guthrie in its recognition. Dumas discovered its composition in 1835, and gave it its present name. Simpson, of Great Britain, in 1847, introduced it as an anesthetic, and used it extensively in his practice.

To Oliver Wendell Holmes belongs the credit for the terms "anesthesia," and "anesthetic." Holmes suggested these names to Morton, who adopted them.

General Anesthesia.—A general anesthetic is an agent which abolishes all sensibility with loss of consciousness. Anesthesia is a term applied to the artificial loss of all sensation which may be either local or general. General anesthesia should not be confused with analgesia, as the latter simply means freedom from pain, consciousness being retained. Therefore, nerve blocking is really a local analgesia, although it is quite true that these terms are confused in this regard.

Anesthesia has developed into a distinct science, and extensive research work has made it a modern discovery. Its great advancement, both general and local, is to be credited principally to the dental and medical professions, as well as laboratory workers of the United States.

Hypnotism.—The ancients recognized a state of hypnotic sleep, which is a condition of anesthesia; but the attention of scientific investigators was not turned in this direction, nor did they realize this fact, until their attention was called to it by the great Mesmer.

The many substitutes used in ancient times, as well as the modern preparations, which may produce loss of consciousness and maintain a state of anesthesia, may be administered in several different ways, such as beneath the skin or into the stomach or through the lungs. By the use of any of these methods the agent is readily absorbed or carried into the blood, and thence to the vital nerve centers and to the brain, thereby producing a state of anesthesia.

The vegetable kingdom furnishes nearly all of the narcotic drugs, and among them are: belladonna, or deadly nightshade, poppy, Indian hemp, henbane, solanum, mandragora, and several others which have been known for many centuries. The inhaling of volatile substances dates back for centuries. According to the literature Ulysses was rendered unconscious or stupefied by nepenthe, and gall or a draught of myrrh and vinegar was offered to Christ upon the cross. The principle of inhaling volatile substances to produce analgesia or anesthesia is very ancient; in fact, it is as old as the practice of medicine itself. In the Third Century a Chinese surgeon is said to have employed some sort of an anesthetic drug, and the Romans used mandrake to stupefy criminals at the time of crucifixion or execution. Mandrake was used as a surgical anesthetic up to the Thirteenth Century, and its use was mentioned by Galen, a surgeon of Naples, who tells of the volatile drugs that were used extensively for anesthesia, namely, hyoscyamus, poppy, solanum, and deadly nightshade. These drugs were kept in a leaden vessel, and when their fumes were inhaled the individual soon passed into a most profound slumber and was rendered insensible to pain. The most common narcotic in Biblical times, according to the best literature, seems to have been alcohol or some of its combinations. Socrates was permitted to drink an extract made from hemlock in order to place himself in a receptive mood and to soothe himself during his last hours. Some writers state that mandragora was much used in the past.

It was Apuleius, of the Thirteenth Century, who said, "If any one is to have a member mutilated, burned, or sawed, let him drink one-half ounce of mandragora with wine, and let him sleep until the member is cut away, without any pain or sensation."

Hasheesh was also used extensively by the Chinese and Indians to produce a stupor to relieve pain. The ancients employed some of these drugs by administering them to condemned criminals before putting them to death. It is also said that a mild intoxication was produced by the drugs among certain fanatics, in order to key them up to a point where they would do heroic deeds, or stimulate them so that they would undertake certain things which they would not otherwise attempt.

It was Guy de Chauliac, who, centuries ago, wrote several surgical articles and referred to agents to combat pain, but even before his time we are told that it was always customary to administer some narcotic drugs or concoction to those who were about to be put to death or to be tortured. The ancients looked upon pain inflicted on their fellow men with due regard, and it seemed to be their intention to render those who were to be put to death, or operated upon, oblivious to pain.

Larrey deserves the credit for first calling attention to the fact that cold diminishes sensitiveness, and he employed it in his practice and called the attention of the profession to the fact that it could be used as a successful local anesthetic.

Mesmer, in 1766, went to Paris, France, and expounded his ideas and demonstrated what he then called "animal magnetism," and the word "Mesmerism" was the term applied later, and the modern term today given to it is hypnotism. Mesmer was able to do operations under its influence, the patients being rendered unconscious to pain. He was able to produce a state of analgesia or anesthesia in his patients, and a number of them were operated upon and were oblivious to any suffering or pain. With all of the agents enumerated, and with all the attempts which surgeons had made throughout the world, none of these agents was efficient or safe. In 1839 Velpeau wrote, "To escape pain in surgical operations is a chimera which we are not permitted to look for in our time."

Sulphuric ether, or ethyl ether, has been known since the Thirteenth Century, but it was not until the year 1846 that its anesthetic properties became known to Morton, a dentist of Boston. After the discovery of ether its composition was not known, and no name was given to it until the year 1730, when Godfrey called it ether. It was not administered by inhalation until 1795. A work published at Bristol in 1796 by Beddoes on "Factitious Airs," contains this statement: "Ether in pectoral catarrh gives almost immediate relief both to oppression and pain in the chest." It was used at the time to relieve the pains of colic. During the year 1812 ether was inhaled for the purpose of entertainment or for experiments, and its peculiar exhilarating, hilarious effects were known. Only a few years elapsed before it was definitely recommended to produce surgical anesthesia, and it was no more than natural that a number of those interested in it were claiming the honor of its discovery.

The Assyrians compressed the large muscles of the neck by a constricting band before operating for circumcision. Theodorico of the Twelfth Century speaks of an oil called "De Lateribus," which was prepared and used by his father, and its fumes were inhaled and the patient put to sleep for painful operations. He also described the substance used upon the somniferous sponge of da Lucca, which consisted of lettuce seeds, mandragora, opium, mulberry juice, wood ivy, hyoscyamus, and water hemlock. When this mixture was boiling a sponge was immersed in the solution, and when it was used it was moistened with water and applied to the mouth and nostrils.

Compression Anesthesia.—During the Seventeenth Century an Italian by the name of Valverdi compressed the large blood vessels of the neck and produced unconsciousness. Compression of the nerves supplying a limb about to be operated, was also practiced. In 1861 Greatrakes made various passes over the patient's body and produced a magnetic sleep and attained considerable notoriety. Potet, a Frenchman, in 1839, demonstrated hypnotism in London. His work was supported by John Elliotson of the University College Hospital, who ruined his practice because of his advocacy of hypnotism. Edsaile, we are told, employed hypnotism with great success during severe surgical operations, and the British physicians Braid, Liston and Simpson were more or less successful in their experiments with it. In the year 1799 Humphrey Davy discovered by experimenting that nitrous oxid would relieve toothache and other pains, and suggested its use as an anesthetic. He described the effects of the gas as "uneasiness being swallowed up for a few minutes by pleasure." It seems that he only produced a slight analgesia, not sufficiently deep to produce unconsciousness. However, he recognized its possibilities in this direction and recommended it as an anesthetic for surgical operations. During the beginning of the Nineteenth Century the effects produced through the medium of nitrous oxid gas were widely known, and the gas was inhaled for amusement by the students of the University of Pennsylvania. It is also stated that "ether frolics" were a great amusement among the young people.

Faraday, in 1818, experimented with ether, and stated that when it was inhaled, its effects were similar to those of nitrous oxid. O. P. Hubbard read a paper before the Medical Association of New York State in which he related interesting circumstances following the administration of nitrous oxid to his brother, in Rome, New York, in November, 1821. It was during one of these exhibitions that a young man was found in an adjoining room completely unconscious and lying beside the anesthetic gasometer. A few moments after he was found he recovered consciousness.

Use of Ether by Long.—In the year 1842, Crawford W. Long, of Georgia, according to literature, is said to have learned from his negro servant named Wichita, that unconsciousness had resulted in a negro boy whose companions had compelled him to inhale ether. Long said he had employed it for relieving pain, and claims to have used it in his first case for the removal of a tumor. Long appeared to be somewhat conservative with reference to his findings pertaining to the anesthetic properties of ether while he was in the limelight of the world. He did not recognize this until after Morton had made known his discoveries of the practical application of ether to general surgery.

Long graduated in 1839 from the Medical Department of the University of Pennsylvania and located in Jefferson, Georgia. After Long began to experiment with ether, it was said that he frequently inhaled the drug and observed its narcotic effects. Following these experiments, it finally occurred to him to test its merits during a surgical operation by removing a small tumor located on the neck of his patient. This was done in May, 1842. Long published the first account of his experiments in 1849. Morton, the dentist, published his findings in the *Medical Examiner* in December, 1846. A careful perusal of the literature gives Morton credit for first making known to the world that surgical anesthesia could be produced through the medium of ether.

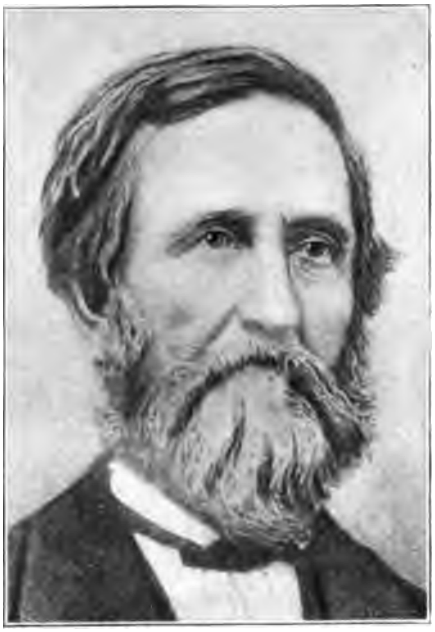

Fig. 1.—Dr. Crawford W. Long, who claimed to have discovered anesthesia by the inhalation of sulphuric ether, at Jefferson, Ga., March 30, 1842.

Observations of Wells.—It was in December, 1844, that Horace Wells, a dentist of Hartford, Connecticut, observed certain things which transpired during a lecture that was being given by a chemist of the name of Colton, who was administering nitrous oxid to a young man by the name of Cooley, a painter by occupation. After the anesthetic was administered Cooley became excited and ran into the furniture, badly bruising his limb. After he regained consciousness he did not remember the accident and complained of no pain. Wells noticed this fact, and immediately began to experiment on himself, and within a few days submitted himself as a patient for the extraction of an aching tooth. The operation was performed by Riggs while Wells was under the influence of nitrous oxid gas. Wells, on recovering consciousness, cried out, "A new era in tooth pulling! It did not hurt as much as the prick of a pin! It is the greatest discovery ever made!" Wells repeated this experiment successfully a number of times upon others, and immediately began the manufacture of nitrous oxid.

Fig. 2.—Dr. John M. Riggs, who extracted Dr. Wells' tooth upon the occasion of the discovery of the anesthetic effects of nitrous oxid gas, at Hartford, Conn., December 11, 1844.

Demonstration of Nitrous Oxid.—In 1845 Wells went to the Massachusetts General Hospital, of Boston, to demonstrate his findings and to show how nitrous oxid could be used as an anesthetic. On arriving in Boston he called upon Morton, his fellow dentist and old partner, who went with him to the hospital to help demonstrate the use of nitrous oxid. The demonstration was a failure, said to be due to the fact that the gas was not administered for a sufficiently long time to produce anesthesia. The audience, which was composed of students and practitioners, was very frank in expressing its disapproval. Wells was very much discouraged on account of his failures and returned to Hartford, Connecticut, where, for two or three years, he frequently conducted experiments with the gas. Very much to his disappointment, all his energies and hard work on nitrous oxid for general surgical purposes met with no encouragement from the medical profession. This perhaps was largely due to prejudice on the part of surgeons and physicians.

Wells explained his findings before the French Academy of Science in 1846. He began the study of dentistry in the year 1834, in Boston, and after completing his work, opened his office in Hartford, Connecticut. Wells was a young man, of great intelligence and ingenuity, and was continually devising and making new instruments. He did a great deal of experimental work, and had no idle hours. The credit of performing the first operation without inflicting pain upon the patient, through the medium of nitrous oxid gas, belongs to him. He died in New York, January, 1848, and it is said that his death was due to his opening a vein while in his bath. This happened a few days before the Medical Society of Paris passed a resolution giving him the honor of having first discovered and successfully demonstrated the value of nitrous oxid in producing anesthesia, whereby surgical operations could be performed without pain. Today there stands in Hartford, Connecticut, a monument erected by the City of Hartford on which the following is inscribed:

Fig. 3.—Dr. Horace Wells, who claimed to have discovered anesthesia by the inhalation of nitrous oxid gas, at Hartford, Conn., November, 1844.

"Horace Wells, who discovered anesthesia, November, 1844."

William Thomas Green Morton was born in 1819 in Massachusetts, and, after business failures in Boston in 1840, began the study of dentistry in Baltimore, and upon graduating, returned to Boston and became a successful dental practitioner. In 1841 he entered the office of Wells, who at that time was located in Boston, and worked as his assistant. In the year 1842 they became partners. Soon after this Morton invented a solder for soldering artificial teeth to gold plates. He carried out extensive experimental work with various drugs and with hypnotism, his object being to find an agent with which teeth might be extracted without inflicting pain. In 1843 the

Fig. 4.—Horace Wells' Monument, Hartford, Conn.

partnership between Morton and Wells was dissolved. Wells then moved to Hartford, Connecticut, and continued his investigations and the practice of dentistry. Morton remained in Boston, and in 1844 entered the office of Jackson, as a medical student. He matriculated in the Harvard Medical School but did not graduate. After Wells returned to Hartford, Connecticut, still continuing his investigations with "laughing gas," he and Morton had numerous interviews on the subject of anesthesia. Morton was not a chemist and he sent for his friend and preceptor (Jackson) and stated his desire in regard to experimental work and the manufacture of nitrous oxid and ether. After Wells met with failure, Morton abandoned gas and experimented with chloric ether, but his results were unsatisfactory. Jackson suggested to Morton that they experiment with sulphuric ether. Morton was then a student of medicine and began his experiments with sulphuric ether on animals. He was successful to a certain extent with his experiments, which encouraged him. In September, 1846, he administered the ether to himself by pouring it upon a handkerchief and inhaling the fumes while sitting in his dental chair. This rendered him unconscious for a considerable length of time, and when he awoke he was highly elated by his success and was about to inhale the drug a second time and submit to the extraction of a tooth while under its influence, when the door-bell rang and Eban Frost entered with his face bandaged up, due to a decayed tooth. Frost asked Morton if he would mesmerize him, but Morton informed him that he would administer ether, which was superior to hypnotism. This was September 30, 1846. The tooth

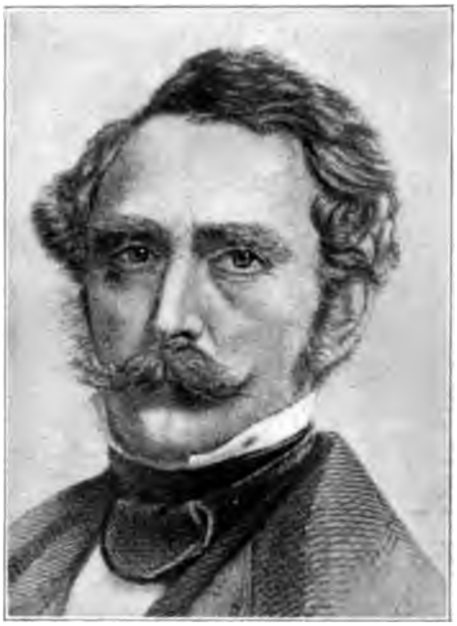

Fig. 5.—Dr. William T. G. Morton, who claimed to have discovered anesthesia by the inhalation of sulphuric ether, at Boston, Mass., September 30, 1846.

was extracted without pain, and both Morton and the patient were elated over the outcome, which was a great success. This marked the first operation under anesthesia produced by ether. As previously stated, Jackson suggested to Morton the use of sulphuric ether, but it was Marcy who suggested sulphuric ether to Wells, saying it was safe to employ and easy to procure. Morton was so pleased with his success that he was eager to obtain publicity and to make known his findings to the public.

Successful Demonstration of Ether as an Anesthetic.—On October 16, 1846, he was furnished the surgical amphitheater of the Massachusetts General Hospital, Boston, where two years before Wells had failed in his demonstration. John C. Warren was the surgeon who operated upon the patient, and much credit is due him because he furnished Morton the opportunity.

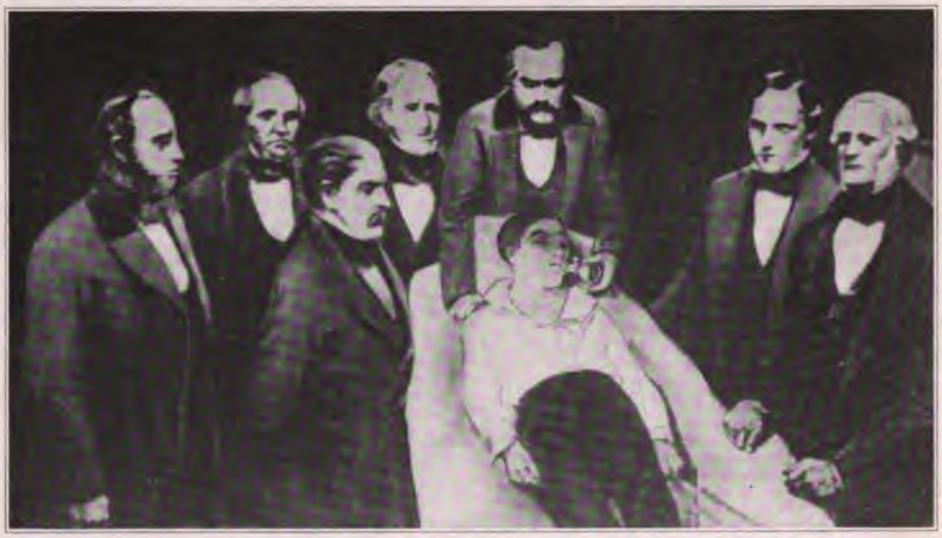

Fig. 6.—Morton's first public demonstration with ether, given in the amphitheatre of Massachusetts General Hospital, Boston, October 16, 1846.

Ether was administered for the removal of a vascular tumor, which was situated on the left side of the neck of a young man, about twenty years of age, by the name of Gilbert Abbott. This demonstration was given in the presence of the senior class of Harvard Medical School, several prominent dentists, surgeons and physicians, and was a great success, and Warren turned to the audience and said, "Gentlemen, this is no humbug." This marked the beginning of surgical anesthesia produced by sulphuric ether, and the results of the demonstration secured by Morton spread rapidly throughout the world. This caused jealousy on the part of Jackson, for he was indeed anxious to share the benefits of this fame. He claimed the right of discovery, and stated that he had known the anesthetic properties of ether since the year 1842, and that he had suggested this agent to Morton, and advised him of its nature and how to administer it, but in spite of all this, his claim was regarded as groundless.

Following this demonstration, Morton went to the office of a patent lawyer and endeavored to secure a patent upon his discovery. This was regarded as the mistake of Morton's life. He asked the lawyer to apply for a patent upon the agent under the name of "Letheon," and urged him to keep its nature secret. At this time, Morton was not a graduate of medicine, and was not bound technically to observe medical ethics in keeping the nature of this anesthetic a secret. The lawyer whom Morton consulted was familiar with Jackson's case, gave the matter considerable time, and consulted with Jackson and Morton. His conclusions were that a joint patent should be issued. Jackson, however, was afraid of the Board of Censors of the Massachusetts Medical Society, should his name be used in attempting to keep the preparation and nature of it a secret. It was finally agreed between them that the patent should be made out, using the names of both Morton and Jackson, and then Jackson was to sign over immediately his interest to Morton, and Jackson was to receive a ten per cent commission on the sales.

Fig. 7.—Dr. Charles T. Jackson, who claimed to have discovered anesthesia by the inhalation of sulphuric ether, at Boston, Mass., in 1842.

On November 7, 1846, Warren, the surgeon, performed an amputation on a patient, Morton being the anesthetist. This operation done under anesthesia was a complete success. Morton at this time disguised the odor of the ether by using aromatic oils, and he continued this practice until the officials of the Massachusetts General Hospital refused to employ the agent because its composition was a secret, and when this action was transmitted to the staff, Morton made a public statement of the fact that he was using sulphuric ether disguised by aromatics. Morton was very anxious to stop Jackson's investigations and notoriety, and accordingly he used the aromatics to disguise the ether. Jackson was dissatisfied and posed as the sole discoverer. A congressional committee investigated the situation and their report substantiated the claims of Morton. After the issuance of a patent covering the method and preparation, Morton began to sell the right to administer it, which resulted in litigation that developed into personal rivalry between Morton and Jackson, their descendants, and friends. Morton attempted to secure remuneration from the United States government to the amount of $100,000 but failed, due, largely, to Jackson's antagonism, whose name was connected with the patent papers. A $50,000 testimonial from England was also a failure, for they were unable to determine to whom the credit belonged. France divided equally a prize between Jackson and Morton.

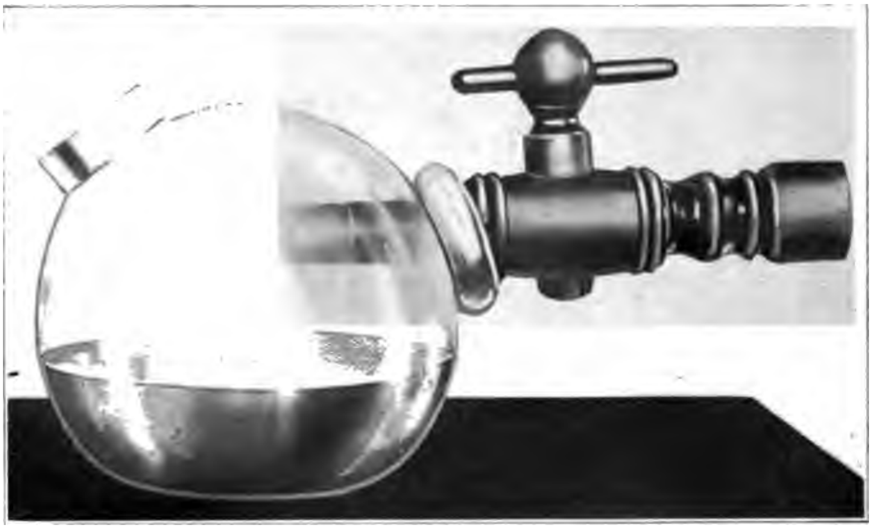

Fig. 8.—Morton's original ether inhaler, at Massachusetts General Hospital, Boston, Mass.

In 1849, the Washington University of Baltimore conferred upon Dr. Morton the honorary degree of M.D. He was also invested by Russia with the Order of St. Vladimir, and by Sweden with the Order of Vasa. A silver box was presented to him with the following inscription engraved upon the front of it:

> "Testimonial in honor of the ether discovery of September 30, 1846."

The lid of the box contained these words:

> "This box, containing one thousand dollars, is presented to William Thomas Green Morton by the members of the Board of Trustees of the Massachusetts General Hospital, and other citizens of Boston, May 8, 1848."

Under the above, are the following words:

> "He has become poor in a cause which has made the world his debtor."

The first surgical operation performed in London, England, under ether anesthesia was for the extraction of several teeth by a dentist named Robertson, in 1846.

Morton lost his health principally from wrangling over the rights of the discovery, and died in 1868. In going over the history of the life and labors of this man, the world at large must honor his memory as a great benefactor. The honor of discovery and the practice of administering ether as an anesthetic are generally regarded as belonging to Morton.

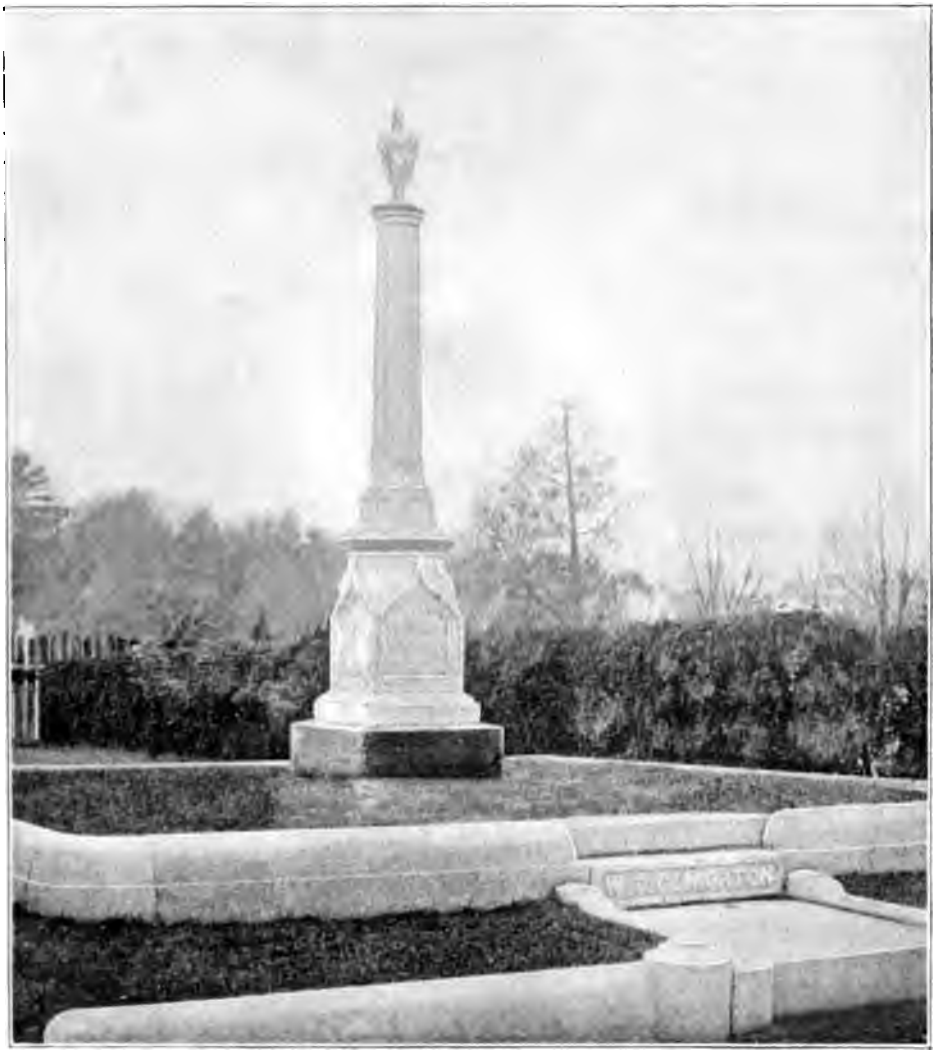
Fig. 9.—Morton's Monument. Mt. Auburn Cemetery, Boston, Mass.

At Mt. Auburn Cemetery, Boston, over the grave of Morton, a monument has been erected by the citizens of that city on which the following inscription is engraved:

> "William T. G. Morton,
> Born August 9, 1819. Died July 9, 1868.
> Inventor and revealer of anesthetic inhalation,
> By whom pain in surgery was averted and annulled,
> Before whom in all times surgery was agony,
> Science has control of pain.
> Erected by the Citizens of Boston."

Jackson graduated from Harvard Medical College in 1829. He was a successful geologist and mineralogist, and was possessed of mechanical ingenuity and scientific talent. In 1835 he opened a laboratory for teaching analytical chemistry. He became greatly interested in anesthesia, and after Morton successfully demonstrated ether anesthesia in the Massachusetts General Hospital he claimed it was he who suggested it to Morton. There arose between them the controversy just referred to, which was carried on for a long time after Jackson's death, which occurred in an asylum. Jackson published a little pamphlet in which he stated that during the year 1837 he discovered ether vapor, which was used in his laboratory for the toxic effects following the inhalation of chlorin gas. He also stated that he inhaled the fumes from ether, in order to obtain relief from irritation caused by inhaling chlorin gas, and described his experience in going to sleep and then awakening. Both Morton and Wells were surprised when they learned of this, and their investigations led to a bitter dispute.

Following the death of Wells, both Morton and Jackson claimed that "laughing gas" could not render a patient insensible to pain; that it was not an anesthetic, and this criticism of nitrous oxid caused the employment of it to be almost abandoned. After the death of Wells, another animated controversy arose as to who should receive the honor of being the first to administer ether during a surgical operation. The surgeons and physicians of the Massachusetts General Hospital and Massachusetts Medical Society joined in a memorial to the Senate and House of Representatives which read as follows:

> "The undersigned hereby testify to your honorable bodies, that in their opinion William T. G. Morton first proved to the world that ether would produce insensibility to the pain of surgical operations, and that it could be used with safety. In their opinion his fellowmen owe a debt to him for this knowledge. Wherefore they respectfully ask a recognition by Congress of his services to his Country and mankind."

Erection of Monument to the Discoverer of Ether.—In the Public Garden, Boston, Mass., has been erected a beautiful monument to the honor of—they dared not say who, so it bears no man's name but that of the generous person who gave ten thousand dollars towards its erection, and the four following inscriptions:

Front side or face:

"To Commemorate the Discovery that the Inhaling of Ether Causes Insensibility to Pain, First Proven to the World at the Massachusetts General Hospital in Boston October, A. D., MDCCCXLVI."

Right side:

"Neither Shall There Be Any More Pain. Revelation."

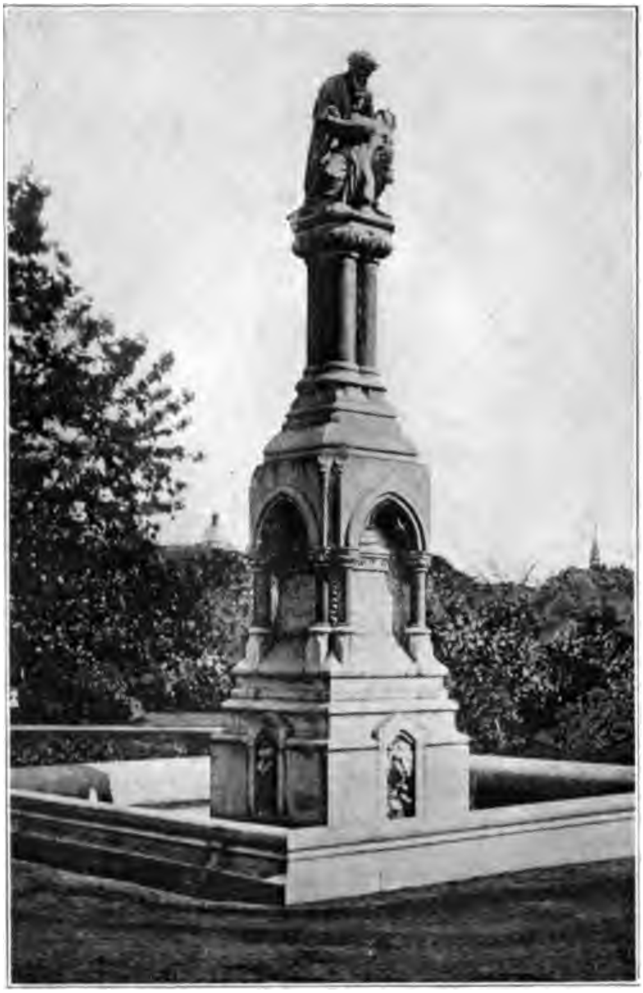

Fig. 10.- Ether Monument. Located in Public Garden, Boston, Mass.

Left side:

"This Also Cometh Forth From the Lord of Hosts Which Is Wonderful in Counsel and Excellent in Working. Isaiah."

Rear:

"In Gratitude for the Relief of Human Suffering by the Inhaling of Ether, a Citizen of Boston Has Erected this Monument, A. D., MDCCCLXVII. The Gift of Thomas Lee."

Wells, Morton, Long and Jackson were hard workers, and the untimely death of each man was, without doubt, largely due to worry and disappointment.

It is also of interest to note how rapidly the news of anesthesia spread throughout the world following the practical demonstrations of Wells and Morton. Soon after Morton's public demonstration of ether in the Massachusetts General Hospital, J. Y. Simpson used it extensively in his obstetric practice. Simpson encountered difficulties in its administration, and abhorred its unpleasant odor, and at once began to search for an agent to take its place. In an article he wrote as follows: "I found no busy obstetric practitioner could extensively employ sulphuric ether without inevitably carrying about with him, and upon his clothes, an odor so disagreeable to many other patients and otherwise as to make his presence aught but desirable." Simpson began his experimental work and inhaled numerous substances. Chloroform was suggested to him by a chemist named Waldie, of Liverpool.

Discovery of Chloroform.—Chloroform was discovered in the United States by Guthrie, in 1831. It was first introduced as an anesthetic agent in Scotland by Simpson, in 1847. On the thirteenth day of November, 1847, the first public demonstration was to be held in the Royal infirmary, using chloroform as an anesthetic. Simpson was to administer the anesthetic, but was not able to reach the clinic in time for the operation, and the surgeon went ahead, performed the operation without an anesthetic, and the patient died on the table. It was stated that had chloroform been employed, and the patient had died, it would have given a death blow to chloroform as an anesthetic. A second clinic was arranged for on November 15th, and the results of it proved a great success. According to this, the name of Simpson went down in history as the one who first introduced chloroform to obliterate pain during surgical operations. Chloroform at that time was described as a "curious liquid."

Guthrie, who discovered chloroform in 1831, was born in 1782, and was a surgeon in the United States Army in 1812. He died in 1848, just at the time when he no doubt would have become famous for the discovery of chloroform as an anesthetic. His recognition as the discoverer of this anesthetic was, probably, largely due to the action taken by the Chicago Medical Society, and, following this, the Historical Society of Jefferson County, New York, recognizing him as the discoverer of chloroform.

After Simpson had made public a demonstration of chloroform anesthesia his discovery was opposed by the Scottish clergymen, who bitterly rebuked him for using chloroform to relieve the pain of childbirth. Simpson proved he could eliminate the suffering which accompanied childbirth, and attacked his opponents and ridiculed them. In the annals of history he is regarded as the third great benefactor to suffering humanity, and as the one who first introduced chloroform for the relief of pain during surgical operations, but not as the discoverer of anesthesia.

Simpson died in 1870, and in Westminster Abbey is found this inscription upon his bust: "To whose genius and benevolence the world owes the blessings derived from the use of chloroform for the relief of suffering."

When Simpson was experimenting with chloroform, he and his coworkers inhaled the fumes and rendered themselves temporarily unconscious. On November 10, 1847, he read an interesting paper before the Medico-Chirurgical Society, stating that he had employed chloroform in a number of cases with complete success, and up to the fifteenth day of November he had administered it to about fifty patients, with no bad results.

Chloroform was first thought to be an anesthetic that could be used without danger, and as a result of the success of various men, it became almost the exclusive anesthetic agent in Great Britain. In America ether was used exclusively and was regarded as reliable and safe for general anesthesia. As time went on, accidental deaths occurred to patients who were under the influence of chloroform, which naturally brought about a great deal of controversy regarding the toxic effects of the agent, and it was a question as to which was the better agent, ether or chloroform. Snow, in the year 1858, wrote an article and stated in his opinion that the many chloroform fatalities which had occurred were due to primary cardiac paralysis, which he thought could be ascribed to the patients inhaling the vapor in a too concentrated form. Later investigators, however, proved that chloroform would primarily affect respiration and the cardiac centers. Snow's conclusions were regarded as correct by many.

Fig. 11. Sir James Y. Simpson, who discovered chloroform to be an anesthetic, at Edinburgh, Scotland, November 4, 1847.

In 1862 Clover did a great deal of experimental work with both ether and chloroform, and his conclusions were that ether was much safer to employ as an anesthetic than chloroform. A committee was appointed by the Royal Medical Society following Clover's experiments to investigate chloroform, and Snow's conclusions were substantiated. This committee recommended that a mixture, which was called the A. C. E. mixture, be used. Its composition consisted of alcohol, chloroform, and ether. The credit for first calling the attention of the profession to this mixture belongs to George Harley.

In the year 1867, Colton, a lecturer, who was an intimate friend of Horace Wells, and who gave him his inspiration to experiment with "laughing gas," took it upon himself to revive the interest in nitrous oxid-oxygen, which was practically dead at that time. Colton made a trip to Paris and administered the gas for Evans, who was a well-known dentist in that city. He also formed an association in New York City and used nitrous oxid extensively while performing dental operations. He was so successful in employing the gas in dental practice that it attracted the attention of many dentists. From that time until the present, nitrous oxid has been gaining in popularity as a safe anesthetic in modern dental practice and in surgery.

Fig. 12.—Dr. Gardner Q. Colton, who administered nitrous oxid gas to Dr. Wells upon the occasion of the discovery of the anesthetic effects of nitrous oxid gas at Hartford, Conn., December 11, 1844.

Use of Oxygen by Andrews.—The credit of using oxygen in combination with nitrous oxid belongs to Andrews, of Chicago. Oxygen was used in combination with nitrous oxid in 1868, using nitrous oxid as an inductive agent to ether anesthesia, and limiting the amount of the anesthetic. This was all due to the research work of Clover. The work done by Andrews and Clover did much to lessen the popularity of chloroform. A number of heated controversies arose with reference to the relative merits and safety of nitrous oxid-oxygen, chloroform, and ether. Several committees were appointed to make investigations, none of the reports from them were at all in favor of chloroform as a safe anesthetic. However, it might be well to mention that the report from the Committee on Anesthesia from the British Medical Association in 1900, stated that ether administered to healthy subjects was practically free from danger; also, that in the majority of cases the dangerous symptoms caused by the administration of chloroform were due to the primary failure of the circulation.

Toxic Action of Chloroform.—Extensive research work was also carried on by Wood, MacWilliam, Hare, and Hill. They found that the great decrease in blood pressure was due to the toxic action of chloroform on the heart, and that general collapse was due to the effects of chloroform on the circulation. For centuries past, the object of those who employed various drugs to produce anesthesia was to inhibit pain during surgical operations, and they did not take into consideration the physical changes or partial consciousness of the patient. As time progressed, they began to realize that a patient could be rendered totally unconscious. Following these experiments they soon realized the great value of prolonging deep anesthesia, and the partial stage of anesthesia was in disfavor.

Since the discovery of various drugs and concoctions for anesthesia, ether, chloroform and nitrous oxid have been used extensively, and many substitutes have been tried with more or less success. Among some of them we might mention ethyl bromid, which was discovered in 1827 by Serullas, and was employed for the first time as an anesthetic by Nunnely in 1849. Balard discovered amylene, and its anesthetic properties were first demonstrated by Snow. Regnault discovered ethidene dichlorid, and Snow demonstrated its anesthetic properties. In addition to these, ethyl chlorid, methyl chlorid, nitrogen, pental and ethylene have been experimented with as anesthetics.

The author will quote from the writings of the late Dr. L. W. Nevius, as follows:

> "It has been said by a certain writer that, 'Reliable history is never written by the generation which makes it.'
>
> "Surely the generation which gave to the world modern anesthesia did not give us a true history of its discovery, notwithstanding the long and bitter controversy in regard to its origin.
>
> "There was too much denying to one another the credit due them for the part they were instrumental in working out. Too much selfishness, each aspirant for the honor being championed by his own personal friends, because of their being more or less connected with the part taken by their friends, or through some jealous motives between the two professions, there having been two physicians and two dentists comprising the four who claimed to have discovered anæsthesia.
>
> "The writer believes that the present generation, or the one next to come, will be sufficiently enlightened and unprejudiced to establish the facts, and award to the person or persons the proper degree of merit due to each. The author of this little volume, believes he has

in his possession enough [illegible] facts and evidence upon the subject to justify him saying:

"1st. That to Dr. Crawford W. Long, [illegible] of Athens, Georgia, belongs [illegible] honor of [illegible] that sulphuric ether was an anesthetic [illegible] surgical operations could [illegible] and were performed [illegible] mentioned year.

"2nd. That to Dr. [illegible] Wells, [illegible] of Hartford, Conn., belongs the honor of having [illegible] 1844 [illegible] an anesthetic, under the influence of [illegible] surgical operations could be, and were performed [illegible] year.

"3rd. That to [illegible] Morton, [illegible] Boston, Mass., belongs the honor of first public [illegible] at the Massachusetts General Hospital at Boston [illegible] administered, is a comparatively safe and [illegible] surgical operations in [illegible] in the above mentioned year.

"4th. That to [illegible] land, belongs the honor of [illegible] an anesthetic, under the influence of [illegible] surgical operations [illegible] and were performed [illegible] year.

"5th. That to [illegible] of [illegible] New York, belongs the honor of [illegible] as a safe and reliable anesthetic after [illegible] a period of fifteen years.

"When [illegible] modern anesthesia and [illegible] of to-day, we must accord to those [illegible] the greatest triumph of modern science. In connection with the names of Long, Wells, Morton, Jackson, Simpson, and Colton we may [illegible] for the discovery of [illegible] and to whom the British House of Commons gave thirty thousand pounds for his discovery. His experiments which finally gave to him a great name and lasting fame, were based upon a simple remark made to him by a young country woman, who, while talking to him upon the subject of smallpox, made the remark, 'I cannot take the smallpox, for I have had the cow pox.'

"These eminent men, whose names have been immortalized, have all (except Dr. Colton) gained an everlasting victory over both pain and death, for they have gone to that world, of which it is written:

"'There shall be no more death, neither sorrow nor crying.'
"'Neither shall there be any more pain.'"

Rapid Strides of Local and General Anesthesia. During the past few years both general and local anesthesia have made wonderful strides in the scientific world, and much credit should be given to research workers for perfecting the methods and teachings in the science of anesthesia. Chloroform is now regarded as a very dangerous anesthetic, and is not used to any great extent in the United States. Nitrous oxid-oxygen and ether are the most popular anesthetics in this country and when they are administered by trained anesthetists the mortality rate is practically *nil*.

There was no real progress made in anesthesia until the year 1844, when Wells first made known to the world surgical anesthesia by nitrous oxid, and in 1846 Morton demonstrated anesthesia by ether. The demonstrations of these two benefactors denote the beginning of real advancement in the anesthetic world, and from that time until now a gradual advance has been made, which is very gratifying to the medical and dental professions.

When Andrews, of Chicago, first used oxygen in combination with nitrous oxid, it was the commencement of nitrous oxid-oxygen anesthesia, and the combination of these two gases as an anesthetic, which have been growing in popularity from that day until the present.

The work accomplished within recent years by George W. Crile, of Cleveland, Ohio, on anoci-association; by Yandell Henderson, of Yale, on rebreathing, and the value of carbon dioxid, will be recorded in history as of great value in the scientific progress of anesthetics.

Credit to Research Workers.—Of the great work of other men and their untiring efforts in research and improved methods of administration of general anesthetics the author mentions with pride the names of Gwathmey, Connell, Hasbrook, and Flagg, of New York; Cotton, Allen, Boothby and Richardson, of Boston; McMechan, of Avon Lake, Ohio; Teter and Henahan, of Cleveland; Gatch, of Baltimore; DeFord, of Des Moines, Iowa; Gallagher, of Ithaca, New York; McKessen, of Toledo; Jones, of Columbus; Seybold and Howard, of Denver; Cunningham and Allen, of Kansas City; Herb, Morgan, Allen, Nevius, Bosworth, Molt, Puterbaugh, and Stowell, of Chicago; Heidbrink, of Minneapolis; Clark, of St. Paul; Gardner, of Rochester, Minnesota; Miller, of Providence; Guedel, of Indianapolis; and Winter, of St. Louis.

CHAPTER II

HISTORY OF LOCAL ANESTHESIA*

The desire to render surgical operations painless through the medium of a local anesthetic is several centuries old; in fact, it is almost as old as the practice of medicine itself, and the history of the efforts of those men who put forth every desire to control pain is one of the most interesting chapters found in medical literature. Many superstitions, some of them very ridiculous, surrounded the combating of pain. Centuries ago physicians attempted to employ methods to dull the sensorium while surgical operations were being performed, and they not only endeavored to use various drugs which would produce a general effect upon the patients to plunge them into slumber, but they searched for an agent which would act locally and secure anesthesia over a circumscribed part. Some of the earliest experimenters employed powdered crocodile skin, or marrow, lizard oil, crocodile fat, and friction with vinegar. Astringent and anodyne applications were used by the Greek surgeons to eliminate or relieve the pain of their wounded comrades.

Literature tells us that cold applications and pressure to the parts to be operated upon were used centuries ago to lessen pain while operating. No doubt they did not realize at that time just what caused pressure anesthesia upon the nerves or know why a degree of numbness followed cold applications to the parts. Neither did they understand just what happened when the Assyrians compressed the carotids of the neck, thereby securing partial anesthesia of the brain by cutting off the normal blood supply. Many circumcision operations were performed by producing pressure upon the penis by ligature. The local anesthetic effect by many drugs was recognized early among the Chinese, and certain tribes among them were obliged to pay their tribute in plants from which these drugs were obtained. The Greeks and Russians for many years called the carotid artery "the artery of sleep." Ointments, lotions, and various concoctions were made from a number of plants by the Greeks, and they employed these compounds for their sedative and analgesic properties. We are told that following the death of Adonis, Aphrodite threw herself upon a bed of mandragora and lettuce, in order to relieve herself of her feelings of grief. Indian hemp was used exclusively by the Egyptians just before they performed a surgical operation. The Egyptians likewise employed the "stone of Memphis," which they thought was endowed with special virtues. This stone was moistened with wine which no doubt liberated carbonic acid gas when applied to the part to be operated upon. The plant mandragora was regarded sacred by many, and ridiculous superstitions surrounded it. The greater its resemblance to certain parts of the human body, the greater the value attached to it. It has been stated that this plant was used 2500 years before Christ by the Babylonians. It was extensively employed by the Hebrews, Egyptians, Hindus, and Chinese.

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*This word should really be analgesia from the fact that consciousness is maintained, and only a local action is the result, but the term anesthesia is too well-known now to be changed.

An idea prevailed among the ancients that instruments, which were made from silver and gold, caused less pain than those made from iron, and many of the ancient surgeons would heat their knives or grease them before operating. No doubt the first method which was of any great value in alleviating pain, was pressure upon nerve trunks, which probably originated with the Arabs centuries ago, and was used more or less up to the Eighteenth Century. In order to bring about partial or complete anesthesia of the nerve trunks, many devices were employed, such as special pads and tourniquets. Most of these special appliances have been abandoned, except the elastic bandage of Esmarch, which is in use today to a certain extent, and when properly applied, will produce anesthesia of a distant part. The method, however, never did, and probably never will, become popular, because the results, so far as anesthesia is concerned, are very uncertain, as it is coupled with pressure pain and the grave danger of gangrene, and last, but not least, in many cases the limb is left affected with motor paralysis. It is quite true that, since ancient times, this method of compression has come into vogue time and time again, and has been rediscovered only to be cast aside on account of the previously named objections. The ancients thought anesthesia was produced by cutting off the nerve supply to the part. The research work of Braun proved the numbness was due to the compression of nerve trunks supplying the parts.

Cold as an Anesthetic.—The application of cold as an anesthetic agent was first used by Seberinus during the early part of the Sixteenth Century. His method of producing numbness or anesthesia was to apply cracked ice upon the part which was to be operated upon. According to Larrey, this method was revived again, following the Napoleonic campaigns in Russia. It was reported by Napoleon's surgeon that he could remove arms and legs without pain, due to their benumbed condition produced by extreme cold. Pain in the extremities was completely abolished, due to the low temperature. These operations caused Arnott and Hunter in the year 1850 to apply freezing mixtures to the part to be operated.

The Ether Spray.—In the year 1886 Richardson invented the ether spray. He was an enthusiastic worker for the advancement of anesthesia, and his method is used today, in the form of the ethyl chlorid spray, to some extent in minor surgery. In addition to the ether spray, many substitutes have been introduced, such as ethylene chlorid, ethyl bromid, etc., but none of them have been adopted to any extent. Ethyl chlorid, as previously stated, is used in minor surgery at the present time. It can be applied independently of room temperature; that is, it can be employed in a practical way at ordinary temperatures, and when released from its containers, it transforms rapidly from a liquid to a gaseous state. It was first described as a freezing agent in 1867 by Rothenstein, and in 1891 it was again revived by Redard as a local anesthetic. Methyl chlorid, koryl, anesthyl, have all been tried and discarded for the reason that they caused injury to the tissues.

Rossbach attempted a number of times to anesthetize deep nerve trunks with ether, also with ethyl chlorid, but his experiments were very unsatisfactory.

Electricity as a Local Anesthetic.—In 1855 electricity was used quite extensively as a local anesthetic, and through this medium it was attempted to carry the drugs to the deep tissues by employing a positive and a negative pole. Without doubt, suggestive therapeutics produced a greater effect than the drug and electricity employed.

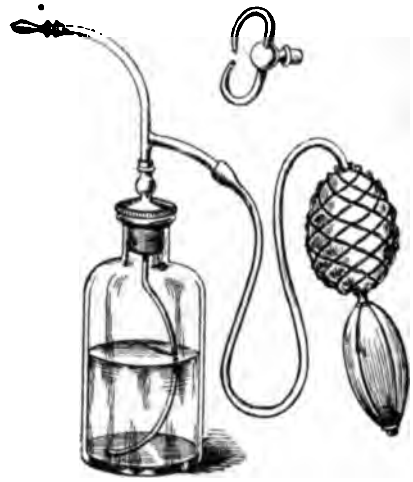


Fig. 13. Richardson's original ether spray.

First Hypodermic Syringe.—In 1845 F. Ryndo, of Edinburgh, invented the first hypodermic syringe, and in 1853 Alexander Wood invented and introduced a hypodermic syringe which was a wonderful step toward local anesthesia. The hypodermic syringe was an entirely new method of applying the various anesthetic solutions to the parts to be operated.

Morphin was the first drug to be injected in the region of the nerve trunks to relieve neuralgia. The credit for this belongs to the inventor previously mentioned. Shortly after this Wood injected chloroform which caused far greater pain to the patient than the operation itself. He also reported many successful cases following morphin injections, and it was stated that local anesthesia was produced. Today we are aware of what happened. The morphin injected caused a general effect on the patient, instead of a local effect, by producing a general, instead of local anesthesia of the part. Following the success of Wood, many experimenters tried various drugs, but none of them proved of any value until Koller in 1884 introduced cocain to the profession. He experimented with this drug extensively, and first applied it in operations upon the eye, throat, and larynx, and did considerable experimental work upon lower animals. It was only a short time following the introduction of this drug to the profession, before it was universally used. He introduced this drug first to the oculists in 1884. Following its use in ophthalmic surgery, its employment spread rapidly and was used in other branches of surgery. Within a few months after the anesthetic properties of cocain were discovered, it was used in every large clinic in the world, and was applied extensively to accessible mucous membranes and cutaneous surfaces. The introduction of cocain as a local anesthetic paved the way for better things. Godeke in 1855 thought he had discovered the active principle of the coca plant which he called erythroxylin. In 1860 the term erythroxylin was changed by Niemann, who gave it the name of cocain. He noticed it would produce numbness of the tongue when he chewed the leaves, or when the alkaloid was isolated and placed upon the tongue. The coca plant or bush from which the alkaloid cocain is obtained grows from three to seven feet in height, and it has a white flower. Great care is exercised after the leaves are picked so as to protect them from moisture and to eliminate any chemical change which might take place between the various substances contained in the leaf. In olden times, this drug occupied a sacred place in the religious rites of the people. It was used by the natives as a stomachic, aphrodisiac, carminative and expectorant, and we know from our present-day knowledge that its action is only minor when used for such purposes. It was also used to promote ideas of self-esteem, cheerfulness and great sentiment. The natives thought it increased muscular activity, or, in other words, acted as a muscular stimulant, and employed the drug to enable them to perform greater deeds, physical and mental, and increase labor, which they thought could be accomplished with less fatigue and nourishment. Its action was further investigated by von Anrep in 1879. He injected a solution made from the alkaloid hypodermically beneath the skin of his arm, and found that it produced an area of profound anesthesia. Anesthesia lasted about forty minutes, and he was able to stick himself with a needle, without pain. Following this experiment he suggested that it might be possible for it to be used during surgical operations as a local anesthetic. It was not employed as a local anesthetic by the medical profession until Karl Koller carried out a series of experiments in 1884. Among the first experiments were those of producing complete anesthesia of the eye, following the applications of a two per cent solution, after which it was employed for nose, throat, and larynx and other surgical operations. As time passed, its disagreeable and toxic properties became known, and quite a number of fatalities were attributed to its use. Since its discovery it has been used extensively in both general and dental surgery, but its toxic action attracted the attention of research workers, and in recent years substitutes have been discovered which caused cocain to fall almost into disuse on account of its untoward and treacherous action. Cocain for local anesthesia was not used extensively until adrenalin was added to the combination, because it was absorbed so rapidly, that it produced toxic effects and anesthesia was transient. Several substitutes for cocain have been prepared which are far less toxic, and yet produce the desired anesthetic effects.

Adrenalin.—When Takamine isolated suprarenal extract, called adrenalin, epinephrin, suprarenin, and other names, it was added to the injecting solution containing cocain. This marked the beginning of modern local anesthesia. Even from this combination, a number of accidents and deaths occurred, due to the idiosyncrasy many patients possessed for cocain, and the toxic results caused research for a drug endowed with less toxic effect.

Spinal Anesthesia.—In 1903 Corning, of New York, introduced a substitute for general anesthesia. He demonstrated his method of spinal anesthesia by making a subarachnoid injection in the region of the fourth lumbar vertebra. This method of anesthesia has been used extensively since its introduction by many surgeons. However, it did not become popular at the time of its introduction. Following the introduction of the method to the medical profession, several papers were published, and the most important was that by the American, Corning, who brought out two important facts, first, that it was possible to obtain a satisfactory anesthesia by injecting solutions of a very low percentage; second, that it was possible to block impulses carried over sensory nerves. He demonstrated in 1885 that a nerve trunk could be easily blocked with a local anesthetic solution. This was the beginning of nerve blocking. (See page 193.) Following the findings of Corning, Halsted blocked the inferior dental nerve and emphasized the importance of employing very dilute solutions, also the intradermal method of injecting the solution. Demonstrations were carried out by both Halsted and Hall, who showed beyond the question of a doubt that a nerve trunk could be blocked by injecting it at any point along its course, thereby producing an abolition of the sensory impulses. In other words, these men proved that anesthesia could be secured in all parts supplied by the nerve trunk injected. This paved the way for greater things and opened up an avenue for much research work to further develop the technic.

Credit to Research Workers.—Within the past few years, research work has been carried on by numerous operators, most of whom have been dentists. The following names are among those who have contributed to the advancement of local anesthesia: Crile, Henahan, Cleveland; Braun and Fischer, Germany; Cushing, Thoma, Boston; Prinz, Philadelphia; Matas, Allen, Kells, Sarrazin, New Orleans; Corning, Blum, Riethmuller, New York; Schultz, Nyman, Puterbaugh, Zoethout, Cary, Emenheiser, Potts, Watson, Miller, Harris, Chicago; Allen, Craig, Hertzler, Kansas City; Hinman, Silverman, Atlanta; Lyon Ann Arbor; Hetrick, Ottawa, Kansas; Shearer, Omaha; Bogle, Neil, Nashville; Rounds, Louisville; and Ogden, Memphis, Tennessee; Seybold, Howard, Denver, Colorado; Litchfield, Humboldt, Nebraska; Nichols, Mandan, North Dakota; and Hallenberg, Fargo, North Dakota. (For names of previous research workers, see page 193.)

It is true that history reveals the fact that local means of producing analgesia dates back prior to the time of the employment of drugs for general anesthesia, and yet general anesthesia employed in a practical way to relieve pain during surgical operations, precedes by many years, the practical application of local anesthetics in the production of local anesthesia. Had local anesthesia been practically applied prior to the time of general anesthesia, the probability is that its development would have been far greater than it is today, and it would undoubtedly be employed in a far greater number of cases for surgery, and it might have been that general anesthesia would be struggling for existence. However, it is certainly very gratifying to both the professions of medicine and dentistry to see the great strides that have been made in the last few years in the various phases of local anesthesia, particularly that of nerve blocking. It is the object of dental and medical procedures to relieve suffering humanity and to prolong life, and those agents which can be used with the least danger and suffering to the patient should always be employed. We should look upon the wonderful progress which has been made during the last few years in the science of anesthesia with a feeling of gratitude, and one of the greatest steps which has been made in experimental chemistry has been to furnish us with several substitutes for that poisonous, treacherous drug, cocain. It is very gratifying to look back over the records and see the scientific progress which has been made. The gradual development of anesthetics employed today, both general and local, has placed anesthesia on the basis of a distinct science. The modern anesthetist carefully selects his anesthetic, and pursues a method of blocking and maintaining anesthesia that is best adapted to each individual case. Until recent years, it was the custom to select only one general anesthetic, but modern research has proved that, in order to attain the desired goal of a shockless operation, it is better to select a combination of methods and follow a certain technic to reach the highest ideal.

The world honors, erects monuments, and writes volumes of flattering histories of great men, but we have seen very little in literature that pertains to the men who discovered and made anesthesia known to the world. It appears to the writer that the world at large is greatly indebted to those men who have contributed so liberally their discoveries and methods to prevent pain during operations, and yet we rarely see this important subject mentioned except in medical history.

Anesthesia is a term given to us by Oliver Wendell Holmes, which stands for that lethargic state which was once the hope and despair of scientists for many centuries, and for the successful application of which Holmes has the following to say: "Nature herself is working out the primal curse which doomed the tenderest of her creatures to the sharpest of her trials, but the fierce extremity of suffering has been steeped in the waters of forgetfulness and the deepest furrow knotted brow of agony has been smoothed forever."

The subject of anesthesia, as well as the constant search for some agent by which pain might be annihilated is as old as the practice of medicine, and there is no other field of medicine and dentistry that has held forth such allurement.

The rapid progress in the anesthetic world which characterizes the past century is a living appeal for the idealism of a less enlightened age. The startling advancement which has been attained in the science of anesthesia gives us great inspiration for further progress, and a realistic tendency for modern thought. Members of the dental profession should feel proud of the fact that both nitrous oxid and ether anesthesia were discovered by dentists. Since these great men made known their discoveries to the world, numerous other dentists have contributed liberally to the advancement of both general and local anesthesia. Therefore, the dental profession should appreciate what its members have done in the advancement which means so much to suffering humanity, and last, but not least, to the elevation of the dental profession in the eyes of the world.

CHAPTER III

DEVELOPMENT OF LOCAL ANESTHESIA

The development of both local and general anesthetics has been amazing within the past few years; and the operator who does not employ agents to eliminate pain, when efficient methods are worked out by science and are at his disposal, is certainly not rendering the best service to his patients. We are always justified in using a soothing, pain-relieving agent, if the condition of the patient and nature of the operation warrants it.

Many methods and numerous drugs have been used experimentally in an effort to improve the technic and lessen the toxicity of the anesthetics which have been used in the past. The untiring efforts and constant research work of many prominent men have, at last, placed local anesthesia upon a scientific basis. A large number of the local anesthetic solutions which have been employed have not fulfilled the requirements of an ideal local anesthetic until within recent years some of the new synthetic compounds have proved to be of great value. The older drugs were protoplasmic poisons, and they not only paralyzed the nerve tissue, but also the protoplasm of all tissue with which they came in contact. Some of the recent synthetic local anesthetics are classed as nonprotoplasmic poisons and have no destructive effect upon the tissues. They have an affinity for nerve tissue which is called "a selective affinity." This is characteristic. They are toxic to the central nervous system because they have a selective power for nerve tissue. When they are injected in large quantities or introduced too rapidly, they not only produce local anesthesia but general toxic symptoms.

Local Anesthesia in Surgery.—Local anesthesia is of great importance in genitourinary operations, ophthalmology, rhinology, laryngology, otology, gynecology, oral surgery, general dentistry and general surgery: in fact, local anesthesia can be used with great success in a large variety of operations, provided the operator understands his anatomy, his technic, and is able to make the injections in a skillful manner. Until recent years local anesthesia was not employed extensively because it had not been developed sufficiently, but within recent years research workers have paved the way, improved the technic, and placed this valuable method upon a scientific basis, so that it is now being used by thousands of surgeons and dentists.

Cocain.—After the discovery of cocain many fatalities followed its use, due to its toxic action, and local anesthesia almost fell by the wayside until Takamine, of the United States, in the year 1901, isolated the active principle of the suprarenal gland, which he called adrenalin. The addition of adrenalin to the local anesthetic solution opened an avenue for greater things. It is now possible to block various nerve trunks located in almost any part of the body with deep nerve-blocking injections, if the technic is properly understood.

The technic which has been developed by various authorities and is being used at the present time, has improved the method, and placed a technic at the door of the surgeon and dentist, the value of which cannot be overestimated. One of the most important features connected with local anesthesia is the fact that it is now possible to inject large quantities of the anesthetizing solution into the body to produce a circumscribed area of anesthesia. The method used in years gone by was principally that of infiltration, but today infiltration anesthesia is only a minor part of the great technic which has been developed in blocking nerve trunks. It is a fact that local anesthesia has been limited to minor surgery, and only a few surgeons or dentists have ever attempted to perform a major operation by this method. Within recent years, however, nerve blocking has been developed on an extensive scale, and many facts are now known; thanks to the scientific technic and untiring efforts of those men who have placed local anesthesia on the high plane which it is enjoying today. Let us pause for a moment and consider general anesthesia, for we must not praise too highly what has been accomplished within recent years in the local anesthetic field, because the technic of administration and the new appliances for giving general anesthetics have developed to a great extent. When a general anesthetic is given by one skilled in its employment, the danger is greatly lessened as heretofore experienced. It is with pride that the anesthetists can say that to a great extent the administration of anesthetics by some incompetent nurse or intern is being eliminated. In addition to this, several anesthetic societies have been organized to stimulate and encourage thorough training, and among these associations we have the American Society of Anesthetists, the Inter-State Association of Anesthetists, and the National Anesthesia Research Society.

America Birthplace of General and Local Anesthesia.—The birthplace of both general and local anesthetics was in America, and their development has, to a large extent, been due to the constant research work and efforts of Americans. The technic of local anesthesia is no longer guesswork, yet it is surprising to see how many still look upon nerve blocking in its various phases with some distrust, which can in most cases be attributed to ignorance on the part of the operator, who is not familiar with the technic in all of its phases. It has been very distasteful to the writer to observe a number of operators attempting to secure results with the various forms of local anesthesia. The very moment he saw them pick up the hypodermic syringe and make the injection at random, he knew positively that satisfactory results could not be obtained, and later these men would say that it was unsatisfactory. These operators were not even familiar with the general principles and the underlying technic which must be observed in order to attain success. Such imperfect technic not only creates dissatisfaction on the part of the patient, but results in the operator casting aside a method which could be of value to him if he really understood it. It is seldom that we hear a patient complaining if the operation has been performed following the successful blocking of all sensation. If a patient has been operated successfully and without pain in either oral or dental surgery, the writer is quite sure the patient would select nerve blocking a second time instead of a general anesthetic. It is usually the patient who has been operated, following an attempt at nerve blocking and has experienced excruciating pain, who demands a general anesthetic. We will now attempt to point out some interesting facts with reference to general or local anesthesia.

Many patients present themselves to the dentist or oral surgeon in a state of greatly lowered resistance, and if a general anesthetic is administered, it might react and further decrease their vitality. Yet these same patients could be given several nerve-blocking injections and be operated for a considerable length of time with perfect ease and comfort, and not experience the undesirable effects which may follow the administration of a general anesthetic. One great factor in favor of nerve blocking over general anesthesia is that it is unnecessary to hurry; neither is it necessary to keep as close a watch on the patient, as is the case if the patient is a bad risk for a general anesthetic. If the operation is being performed under block anesthesia the operator is enabled to do a more careful and thorough operation. He protects and manipulates the tissue more carefully, all of which is in favor of postoperative recovery of the patient, than when the operation is done hurriedly and every effort is put forth to shorten the period of anesthesia, which is sometimes the case when a general anesthetic is employed. Besides a large number of major operations which can be performed successfully under nerve blocking, we mention in a general way a long list of minor operations that are often considered too insignificant for the employment of a general anesthetic, among these are the opening of abscesses, furuncles, skin grafting, circumcision, exploratory punctures, etc. All of these operations which seem to be of little importance to the surgeon, cause pain and this can be avoided through the aid of the local anesthetic and proper technic.

Another important factor in favor of local anesthesia is that patients who have to undergo a surgical operation will submit many times to a local, when they would not to a general anesthetic. Local anesthesia can also be used with great satisfaction in securing a small piece of tissue from a tumor or growth for microscopic examination. Many persons having benign tumors, ingrowing toe nails, disfiguring scars, and other conditions of a similar nature, would gladly welcome nerve blocking as a medium for relieving them of all pain during operation. Local anesthesia is also employed to great advantage when the operator has no trained assistant who can aid in the administration of a general anesthetic. Practically all patients will submit to nerve-blocking injections in preference to general anesthesia for such operations as the preparation of sensitive cavities, curetting of pus pockets, operations upon the antrum, extraction of teeth, removal of badly impacted third molars, periodontia, pyorrhea treatment, resection of alveolar process, the removal of pulps, the preparation of teeth for bridge work, as well as other operations coming under the observation of the oral and dental surgeon. If the operation is to be performed within the oral cavity, an almost bloodless field is secured, which is of great advantage to the operator, as the patient can cooperate with him as the operation proceeds, and the inspiration of blood and mucus is not likely, as is the case many times when a general anesthetic is employed.

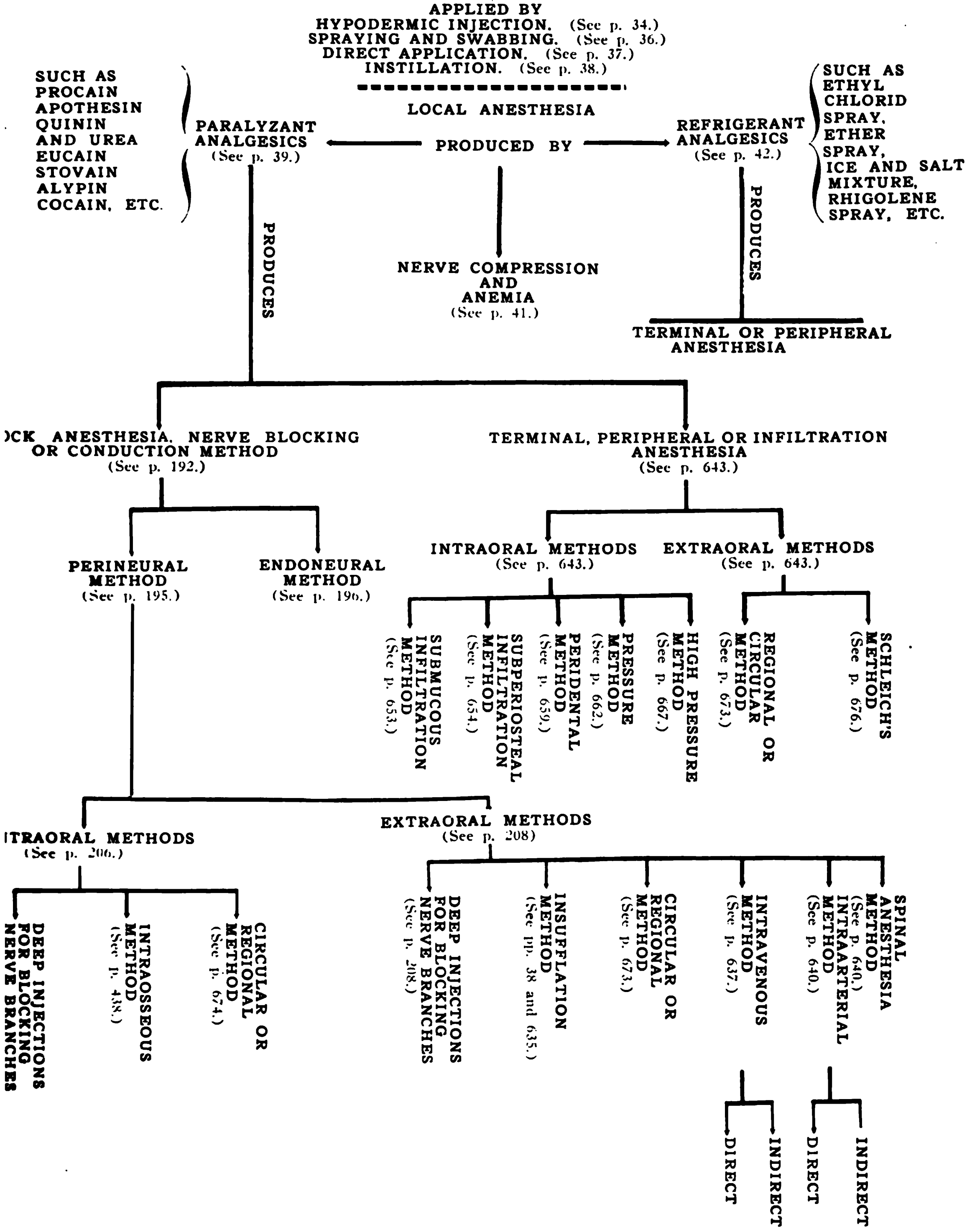
If the patient is suffering from some pulmonary or circulatory involvement, in most cases the operation can be performed under nerve blocking with little or no appreciable change in the patient's general condition. The absence of nausea and vomiting during or following the operation is another advantage in favor of nerve blocking. It is impossible to state any definite rule as to whether local or general anesthesia should be employed, but in general it can be said that when the operator is familiar with the nerve blocking technic in all of its phases, and the area to be operated upon is supplied by nerve trunks readily reached with the needle, and the patient's confidence can be obtained, local anesthesia should be employed. In most cases the confidence of nervous individuals can be obtained when a proper explanation is given them by the operator, and with the addition of a sedative drug, nerve blocking can be successfully employed.

Nerve-blocking Anesthesia can be employed with great success on children, provided the operator has obtained their confidence. The employment of local anesthesia on children depends on whether or not the operator can obtain their confidence, and once their confidence has been obtained, these little patients feel very grateful, and the dental operations which can be performed are unlimited. Many times the dentist is called upon to remove badly broken-down first permanent molars or to prepare cavities or remove pulps in these teeth, and nerve blocking is a blessing to both the operator and patient. The operator must use tact and skill with children and eliminate all fear and pain while making the injection, which can be done in most cases.

Research workers have striven diligently to evolve methods of producing anesthesia by nerve-blocking in oral surgery, head surgery, and operative dentistry while the patient is fully conscious. Such hope is now a reality, as pain can be eliminated through the practical application of some form of local anesthesia. In making this statement the author does not wish to belittle general anesthesia, especially nitrous oxid and oxygen in any way whatsoever, as it is far from his intention to detract, in the least possible way, from that general anesthetic which has been and is so valuable to both the oral and dental surgeon. *Nitrous oxid and oxygen is a very valuable general anesthetic, and certainly has its place just the same as local anesthesia, and it is far better for the operator or anesthetist to be familiar not only with local anesthesia in all of its phases, but general anesthetics in all of their phases, and then select the anesthetic in accordance with the indications and contraindications of the individual patient.* There are certain operations and certain types of patients, as classified elsewhere, which demand general anesthesia. The same thing holds good for local anesthesia. The face, jaws, neck and cranium offer particularly favorable fields for operations under local anesthesia, for the nerves have in most cases a definite location and their accessibility makes some form of nerve blocking an easy procedure, when the operator understands the technic.

The accompanying chart shows the author's classification of local anesthesia. Each division will be discussed under its respective heading.

LOCAL ANESTHETICS


APPLIED BY
HYPODERMIC INJECTION. (See p. 34.)
SPRAYING AND SWABBING. (See p. 36.)
DIRECT APPLICATION. (See p. 37.)
INSTILLATION. (See p. 38.)
LOCAL ANESTHESIA
PRODUCED BY
SUCH AS PROCAIN APOTHESIN QUININ AND UREA EUCAIN STOVAIN ALYPIN COCAIN, ETC.
PARALYZANT ANALGESICS (See p. 39.)
REFRIGERANT ANALGESICS (See p. 42.)
SUCH AS ETHYL CHLORID SPRAY, ETHER SPRAY, ICE AND SALT MIXTURE, RHIGOLENE SPRAY, ETC.
NERVE COMPRESSION AND ANEMIA (See p. 41.)
PRODUCES
PRODUCES
TERMINAL OR PERIPHERAL ANESTHESIA
)CK ANESTHESIA. NERVE BLOCKING OR CONDUCTION METHOD (See p. 192.)
TERMINAL, PERIPHERAL OR INFILTRATION ANESTHESIA (See p. 643.)
PERINEURAL METHOD (See p. 195.)
ENDONEURAL METHOD (See p. 196.)
INTRAORAL METHODS (See p. 643.)
EXTRAORAL METHODS (See p. 643.)
SUBMUCOUS INFILTRATION METHOD (See p. 653.)
SUBPERIOSTEAL INFILTRATION METHOD (See p. 654.)
PERIDENTAL METHOD (See p. 659.)
PRESSURE METHOD (See p. 662.)
HIGH PRESSURE METHOD (See p. 667.)
REGIONAL OR CIRCULAR METHOD (See p. 673.)
SCHLEICH'S METHOD (See p. 676.)
ITRAORAL METHODS (See p. 206.)
EXTRAORAL METHODS (See p. 208)
DEEP INJECTIONS FOR BLOCKING NERVE BRANCHES
INTRAOSSEOUS METHOD (See p. 438.)
CIRCULAR OR REGIONAL METHOD (See p. 674.)
DEEP INJECTIONS FOR BLOCKING NERVE BRANCHES (See p. 208.)
INSUFFLATION METHOD (See pp. 38 and 635.)
CIRCULAR OR REGIONAL METHOD (See p. 673.)
INTRAVENOUS METHOD (See p. 637.)
INTRAARTERIAL METHOD (See p. 640.)
SPINAL ANESTHESIA METHOD (See p. 640.)
DIRECT
INDIRECT
DIRECT
INDIRECT

CHAPTER IV

METHODS OF APPLYING LOCAL ANESTHETICS

Local anesthetics are applied as follows:

1. Hypodermic injections.
2. Spraying and swabbing.
3. Direct application.
4. Instillation.

Hypodermic Method.—The invention and practical application of the hypodermic syringe has really been the making of local anesthesia, inasmuch as the anesthetizing solution can be injected into the deep tissues for the purpose of blocking the nerve trunks, or it can be injected beneath the skin or the mucous membrane, in order to produce terminal anesthesia. In addition to being able to inject the solution into the deep tissues, it also gives us a method whereby an accurate and known amount of the solution can be used.

An efficient working hypodermic syringe is a wonderfully useful appliance and there have been some controversies as to whom the credit belongs for its invention. In 1853 Wood introduced a hypodermic syringe which he invented, and most writers give him credit for being the originator. He wrote numerous articles and gave many practical demonstrations which popularized the syringe almost the world over. In 1862 an excellent hypodermic syringe was manufactured in France, which was somewhat similar to the hypodermic syringe used today. It is of interest to note the rapid strides that have been made in perfecting syringes within recent years, and so many improvements have been made that we are now able to state that the hypodermic syringe has reached a high state of perfection. It is absolutely essential that the operator use an efficient syringe and the proper needles for making the various injections.

The hypodermic method of local anesthesia embodies a number of highly important features, and to overlook any one feature may be the cause of failure.

Important Factors to Remember to Achieve Success.—The operator must adhere to the following in order to obtain success:

1. Strict adherence to asepsis.
2. A most thorough knowledge of all anatomic parts.
3. The technic must be mastered.
4. Diagnosis of all existing conditions.
5. Judicious selection of the correct method to be employed in each individual case.

6. The syringe must be of proper size and construction, and must not leak.

7. The syringe should assume the position in the hand similar to that of a pen in writing while the needle is being inserted in the proper direction in the tissues.

8. There should be no lateral pressure on the syringe in order to eliminate the possibility of breaking the needle.

9. Proper needles must be used for the various injections.

10. The needles should be of certain known lengths and diameters and have the proper bevel. Iridioplatinum needles are preferred because they can be sterilized in flame, and will not break easily.

11. Other necessary hypodermic equipment, which has been carefully selected, should be on hand and ready to use.

12. The needle should never be inserted into the tissue up to the hub, for if it is accidentally broken, considerable difficulty may be encountered in its removal. It is always advisable to leave at least one centimeter of the needle in view.

13. While inserting the needle the wrist should be perfectly free and relaxed.

14. The hand must be trained in order to skilfully manipulate the syringe, and only one hand should be used, the other hand taking care of the tongue, cheek, etc.

15. The needle should be moved back and forth slightly while the solution is being discharged.

16. The area for the insertion of the needle must be free from moisture, and a germicidal solution properly applied.

17. The use of an isotonic (Ringer) sterile anesthetic solution containing a known amount of the anesthetic and vaso-constricting agent.

18. The injecting solution should contain a sufficient amount of adrenalin or synthetic suprarenin to maintain anesthesia. The time element depends on the amount of adrenalin or synthetic suprarenin employed.

19. The anesthetizing solution must correspond to the physical laws of osmotic pressure and the physiologic laws which govern the functions of the tissue cells.

20. A known quantity of the solution should be injected, the amount depending upon the nerve trunk or trunks to be blocked and the skill of the operator.

21. The solution should be near the body temperature when injected.

22. The solution must be injected, always observing Laewen's rule to inject slowly.

23. Never inject the solution for deep injections beneath the periosteum, into ligaments or muscle tissue.

24. Always wait a sufficient length of time to allow the anesthetic to anesthetize the part before starting to operate.

25. Always be positive that anesthesia has been secured before attempting to remove a pulp, extract a tooth, or do other operations. Test out the case carefully and ascertain what depth of anesthesia has been secured.

26. If you have failed to secure a satisfactory anesthesia, make the injection again, provided the patient's physical condition will permit it.

27. Never inject any more of the solution than is absolutely necessary, and always see how little, instead of how much, you can inject.

28. Always obtain and maintain the confidence of the patient. Promise your patients you will not hurt them, and then keep your word.

29. If you fail, remember it is undoubtedly your faulty technic and not the method.

Spraying and Swabbing Method.—Local anesthesia can be produced by swabbing or spraying. The swabbing process consists of applying the local anesthetic powder direct to the mucous membrane, or a solution of local anesthetic by the aid of cotton or gauze upon a wooden applicator. The application of the local anesthetic through the use of the swab is employed to a considerable extent by the nose and throat specialists for anesthetizing mucous membranes for various nasal and throat operations. Some throat specialists attempt to employ this method exclusively for anesthetizing the tonsils for tonsillectomy, but it is not to be recommended for surgery of this kind because the anesthetic in many instances does not penetrate and permeate to a sufficient depth to enable the surgeon to perform the operation without inflicting pain.

The solution generally used in the past for this method was an aqueous solution containing 10 per cent of cocain, and 5 per cent carbolic acid, however, some operators used a solution of cocain and adrenalin. Three to five applications are usually required to produce anesthesia, but since the introduction of less toxic synthetic anesthetics, cocain at the present time is not being used to such an extent as in the past. The applicator is moistened in adrenalin solution, the excess removed from it, and then dipped into the powdered anesthetic. The crystals of the anesthetic adhere to the moist cotton held by the applicator; the surplus is removed, and the applicator is then carried to the mucous membrane and swabbed back and forth over the entire surface, using enough pressure to massage the surface of the mucous membrane, which will aid in causing absorption of the anesthetic. There should be an interval of five minutes allowed to elapse, and then a second application can be given. After the second application, if the anesthesia is not profound, a third application should be made.

The advantages of applying the powdered local anesthetic, instead of the solution, are the comparatively infrequent toxicity and the speed of producing a profound anesthesia.

Operators who use cocain, instead of the more recent and safer drugs, employ from 4 to 10 per cent solution for application to the nasal septum. However, if the application is to be made to the eye, a solution of from 10 to 20 per cent is employed, as only a small quantity of the solution is absorbed.

It appears to the author that strong solutions of cocain are nearly always unnecessary, since much weaker solutions induce profound anesthesia of the mucous membrane, if properly employed. It is self-evident that a solution of a low percentage of 2 or 3 per cent, if properly applied, will give much better results than a solution of 20 per cent, used improperly.

One of the greatest mistakes made by both the nose-and-throat specialist and the dentist in applying a local anesthetic to the mucous surface is that they do not paint the entire surface of the mucous membrane, and do not allow sufficient time for absorption before beginning to operate.

Many rhinologists cleanse the surface with a spray, and then apply the powdered anesthetic direct to the mucous membrane with an applicator, first dipping the applicator in a solution of adrenalin. After the anesthetic has been applied to the mucous membrane, it stimulates the flow of mucus which may prevent the anesthetic from permeating the tissues. The mucus may adhere to the applicator, and when this occurs fresh cotton or gauze should be used on another applicator. The mucous membrane lining the nasal cavity, and also the tissues situated within the field of the oral and dental surgeon, are readily reached by the swab in most cases. However, if any part is not accessible, it will be found that the spray is very useful, for it can be employed to advantage in securing anesthesia of those parts which can not be readily reached by the swab. When the spray is employed, great care should be taken not to use an excess of the solution, but only to spray enough to moisten the surface of the mucous membrane. (The technic of block anesthesia for tonsillectomy, which was introduced by the author to the eye, ear, nose, and throat specialists, is given in Chapter XXXIII.)

Swabbing Method.—The swabbing method is of some advantage to the oral and dental surgeon in applying the powdered anesthetic, or a strong aqueous solution to the mucous membrane prior to making a deep nerve blocking injection.

In addition to applying the powdered local anesthetic or aqueous solution, gratifying results can also be obtained by saturating a small piece of gauze and holding it in contact with the part for several minutes. This method of application can be utilized to advantage in allaying the hypersensitiveness of the soft palate and other parts prior to taking an impression for a denture. The prosthetist will find many times that this simple method will save him a lot of time and trouble, by the avoidance of nausea, when taking impressions.

The Spray.—The first spraying apparatus was introduced by Richardson in 1866, in which he sprayed sulphuric ether upon the tissue in order to produce local anesthesia. Later on, ethyl chlorid and other highly volatile substances were employed. This method of anesthesia is of some value, if used in an intelligent manner, and applied only when indicated. A description of its methods and uses will be given under the heading of "Refrigerant Analgesics."

Direct Application Method.—By direct application is meant the applying of the local anesthetic to the tissues such as the mucous membrane, through the medium of: (1) A swab with applicator. (2) A tampon containing the aqueous anesthetic solution. (3) Applying the powdered anesthetic direct to the part.

The direct application method is used with success in the treatment of affections of the nose and sinuses. The anesthetic is applied to the part with a tampon, which has been soaked in the solution, and left in place from five to fifteen minutes. The solution used is either 10 per cent cocain *plus* adrenalin, or a 20 per cent solution of procain *plus* adrenalin. This method, if properly applied, not only gives satisfactory anesthesia, but in addition it produces a contraction of the mucous membrane which will permit a most thorough examination, and enables the surgeon to operate upon the mucous membrane and adjacent parts.

Insufflation Anesthesia.—Petach succeeded in anesthetizing the upper anterior teeth and the lower part of the nostrils with a solution of cocain. He demonstrated his findings to the profession in 1884, and called this method "Insufflation Method of Local Anesthesia." In 1908 de Terra improved the technic and presented it to the profession. This technic was as follows. For anesthetizing the upper right central and lateral, he applied the local anesthetic solution on a tampon through the nostril on the right side, and *vice versa* for the teeth on the left side. The patient sits in an upright position with the head tipped downward. De Terra used a cocain adrenalin solution and applied it to the mucous membrane in the nasal cavity, directly over the centrals and laterals with a tampon which had been saturated in the anesthetic solution. Prinz says that "the intimate relationship of the anterior superior dental nerve with the nasal mucous membrane explains satisfactorily the anesthesia of the upper teeth following anterior intranasal anesthesia, for in 47 per cent of the cases the cocain tampon is separated from the anterior superior dental branch by only the mucous membrane, and in 53 per cent of the cases the tampon is separated by a very thin lamina of osseous tissue through which it is easy to conceive the anesthetic readily reaches the nerve." The author has employed this method in quite a number of cases, with satisfactory results for operations involving the incisors. In most cases the lingual side must be blocked. A 20 per cent solution of procain with adrenalin is employed.

Instillation Method.—The instillation method is defined as the process of dropping the local anesthetic solution upon the tissue or into a cavity. This method is employed most frequently by ophthalmologists in dropping a local anesthetic solution into the eye. Koller demonstrated this method in 1884. The cornea can be quickly and easily anesthetized for the removal of foreign bodies by introducing one drop of a 4 per cent solution of cocain, or a 20 per cent solution of procain, repeating the process several times with two or three minute intervals.

Many ophthalmologists employ a 5 per cent solution of cocain, using a medicine dropper and placing one minim in the eye, and in a few minutes repeating until three or four applications have been made, which is sufficient to anesthetize the cornea for the removal of foreign bodies.

CHAPTER V

METHODS OF PRODUCING LOCAL ANESTHESIA

Local anesthesia is produced by three different methods, which are:

1. Paralyzant analgesics.
2. Refrigerant analgesics.
3. Nerve compression and anemia.

Paralyzant Analgesics

Definition.—Paralyzant analgesics are drugs having a specific paralyzant action upon sensory nerve trunks, nerve branches or nerve endings. A local anesthetic can, therefore, be defined as an agent which is endowed with a specific paralyzant action upon nerve tissue and when injected possesses the power of rendering a circumscribed area insensible to pain. A definition which could be used, but which is not absolutely correct, is: "A local anesthetic is an agent that anesthetizes only the part to which it is applied." The latter definition does not hold good with nerve blocking, inasmuch as by this method the tissue at a distance is blocked, or, in other words, distal to the point of injection, while the latter definition states that only the part injected is anesthetized. This is quite true if infiltration anesthesia is used, or, in other words, if the anesthetic solution is injected directly into the tissue that is to be operated, or is injected near the tissue to be operated and allowed to infiltrate the operative area, while in nerve blocking all sensation is blocked in a circumscribed area, which in many cases is located quite a distance from the point of injection.

Division of Local Anesthetics.—Prinz divides local anesthetics into two forms, that is, the primary, or true; and secondary, or painful. A true local anesthetic is one that is endowed with the power of acting immediately upon the terminal nerve, while the secondary, or painful, are those anesthetics which are endowed with the power of being very slow in action before insensibility to pain in the part takes place, which is succeeded by a period of intense irritation.

Examples of the primary true local anesthetics are procain, apothesin, quinin and urea, cocain, eucain, etc., while examples of the secondary or painful anesthetics are certain essential oils, sodium bromid, potassium bromid, etc. We might add here that within recent years several insoluble synthetic anesthetics have been prepared and are endowed with a marked local analgesic power when applied to an excoriated or abraded painful mucous membrane or skin surface. These agents are practically insoluble in water or body fluids, and as a result are practically nontoxic, due to very slow absorption. Examples of such compounds are orthoform, and orthoform new, propaesin, cycloform, subcutin, anesthesin, etc.

The soluble local anesthetics are those which are injected into the tissue with a hypodermic syringe and examples of such are procain, cocain, apothesin, quinin and urea, alypin, stovain, eucain, etc.

Action of Local Anesthetics.—According to the conception of Preyer, local anesthesia is produced as follows, using cocain as an example: cocain possesses a definite and distinct affinity for the protoplasm of the nerve cell, and when the anesthetic solution comes in contact with the nerve tissue, a labile union is formed which lasts for a short time, thus bringing about a state of anesthesia. When this temporary union is broken, which is brought about by the dissemination and absorption of the anesthetic, the original form of cocain is split up into simpler or less complex compounds, and sensation returns to the parts injected. It seems that the nerve tissue has the power to first combine or form a temporary union in some unknown way with the anesthetic, and after a time it is endowed with the power to rid itself of the anesthetic by causing a breaking down of the compound. All local anesthetics to be effective should be capable of absorption, therefore, if a soluble local anesthetic is applied topically to the mucous membrane, absorption takes place and a superficial anesthesia is produced. If a local anesthetic is applied to the unbroken skin, no anesthesia will be produced as the horny layer of the skin prevents absorption and the anesthetic solution must therefore be injected with a hypodermic syringe in order that the solution reach the terminal nerve endings. When injecting the solution into the tissue it is imperative that rapid absorption by the injected part be prevented, which is accomplished by two methods, *first,* by the addition of a vaso-constricting drug to the injecting solution, such as adrenalin or synthetic suprarenin; *second,* by the application of a bandage near the point of injection. The latter method is of little or no value in block anesthesia for oral and dental surgery, as it is difficult or impossible to apply the bandage, owing to the shape of the anatomic parts of the head and neck, but the bandage has practical merit for general surgery, as for the amputation of an extremity, such as a toe, finger, arm, or leg.

Paralyzant analgesics are not only of value in the production of local anesthesia for surgery, but are valuable in the treatment of certain reflex conditions, such as hypersensitiveness of the mucous membrane of the mouth, especially in the soft palate region. Many operators have, no doubt, experienced difficulty in taking impressions for dentures in the mouths of certain patients.

Neuralgia is also helped many times by the application of a local anesthetic.

Within recent years the therapeutic value of local anesthetics in the treatment of inflammation has been called to the attention of the profession and they have been employed by many of its members.

Speiss was one of the first to advocate a local anesthetic in the treatment of inflammation. He says: "When the exposed nerve fibers are brought in direct contact with the anesthetic, they at once become insensible, but the anesthetic must not interfere with the blood vessels or act as a vasoconstrictor. The important factor in this treatment seems to be to bring and to hold the local anesthetic in close contact with the wound surface until all subjective pain is more or less abolished, and to keep the wound surface in this analgesic state." Procain is ideal for this purpose and does not possess the vasoconstricting power of cocain, and is ideal to treat abraded and lacerated tissue, antrum cases, painful sockets, etc.

NERVE COMPRESSION AND ANEMIA

Anesthesia produced through the method of nerve compression and anemia is of little importance to the oral and dental surgeon with the exception that it can be used to advantage to reduce or eliminate the pain while advancing the needle through the skin for extraoral injections. The compression of nerve trunks was one of the first methods to be of any real service in local anesthesia. It was practiced in the Seventeenth Century by the Arabs, and even at the present time some special bandage or tourniquet is employed to produce compression.

The Tourniquet.—The best form of tourniquet used today, and which is indeed a very popular one, is known as the Esmarch elastic bandage. When this bandage is properly applied, it will in most cases produce anesthesia of the part distal to the bandage. It can be used for minor operations on the toes and fingers. This plan of producing local anesthesia will never become popular on account of the pain the bandage produces from pressure, the time necessary to produce anesthesia and its uncertainty. Prolonged compression, as from a bandage, may lead to atrophic changes. A striking example of this is in paralysis of the arm following a general anesthetic when the muscles have been completely relaxed and the arm allowed to hang over the edge of the operating table or in some abnormal position which causes compression on the branches of the brachial plexus, thus producing complete anesthesia or paralysis.

There is also danger of causing gangrene if pressure is applied to a part extending over a period of time, especially if the pressure is combined with anemia of the tissue.

Esmarch Bandage.—The application of the Esmarch bandage to an extremity for confining the local anesthetic which is given under "intravenous anesthesia," is of great value. The analgesic or numbing effect caused by pressure upon any part of the body is well known to all. Almost every individual has had the experience of his foot or arm "going to sleep," so-called by the layman, which is caused by pressure on the arm or limb in being held in an abnormal position indefinitely. It is possible to carry the analgesic stage to such a depth as to cause depression of both the painful and tactile impressions. The analgesic effect is produced in two ways:

1. By a diminution of blood in the part.

2. By thoroughly paralyzing the nerve endings of the part due to the pressure.

As before stated, nerve compression is of no practical value in oral and dental operations, with the exception of producing a local analgesic effect of the skin where the needle is to be inserted through it for making extraoral injections. This is accomplished by picking up the skin between the thumb and index finger and squeezing it considerably for two or three minutes, which will produce anemia of the part, and the pressure will paralyze the peripheral nerve endings which will render the part partially insensitive.

REFRIGERANT ANALGESICS

Refrigerant analgesics are those substances which cause a rapid abstraction of heat from the tissues, thereby producing diminished sensation, and their prolonged application produces local anesthesia. The temperature of the tissues is rapidly lowered, and the terminal nerve endings are rendered incapable of receiving painful afferent impulses.

The method of producing local anesthesia through the application of refrigerant agents has in the past been used to considerable extent, but at the present time has been replaced by more efficient methods. Arnott in 1848 employed the "means of cold" in producing anesthesia for surgery. He employed a mixture of ice and salt which was placed in rubber bags and applied to the part to be operated. Anesthesia was confined to the outer part of the skin and practically no anesthesia was obtained in the tissues extending beneath the surface. This method is of exceptional value in skin grafting by Reverdin's method, where small fragments of epidermis are removed. The author has removed small pieces of epidermis for the purpose of skin grafting by applying ice to the skin and allowing it to remain for several minutes; the anesthesia is sufficient to allow the skin to be removed without pain to the patient.

Sulphuric Ether.—Sulphuric ether was first used as a refrigerant analgesic by dropping it into the wound.

As stated, Richardson devised the first spraying apparatus whereby the ether could be sprayed upon the field of operation. He also used chloroform in the same apparatus. This ether spray was equipped with a metal tube, on the end of which was attached a very fine point. To the metal tube was attached a rubber bulb which was used to force air into the bottle which displaced the solution. When the ether was sprayed against the tissue it evaporated quickly, thereby lowering the tissue temperature. It is an easy matter to reduce the temperature to a minimum of 20° C., with the ether spray.

Technic.—The technic for using the ether spray is to hold the nozzle at a distance of 6 cm. from the part to be anesthetized while a small spray is directed upon the part. A pure water-free ether is necessary, similar to that used for general anesthesia, having a boiling point of 95° F., and a specific gravity of .720.

Ethyl ether has a chemical formula of $(C_2H_5)_2O$, and for the best results it should be at least 95 per cent pure. Its boiling point is 95° F., is highly volatile and inflammable, and when its vapor is mixed with air and ignited, it will explode violently. It should, therefore, not be used near a flame or an actual cautery.

Ethyl Chlorid.—This compound has the chemical formula of C_2H_5Cl.

Synonyms.—*Kelene; narcotile* and *antidolorine.* It is a colorless, highly volatile, mobile liquid, and has a characteristic, agreeable odor and burning taste. It boils at 55° F., and is highly inflammable and should not be employed near a flame or actual cautery. It is best preserved in hermetically sealed glass or metal containers.

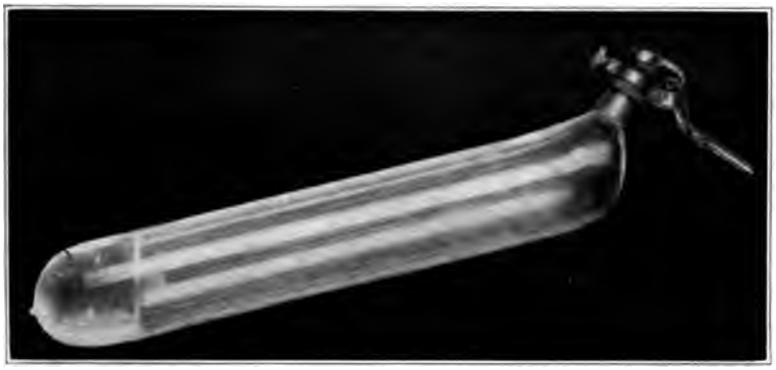


Fig. 14.—Ethyl chlorid container, composed of glass and equipped with a metal nozzle.

In 1867 Rottenstein employed ethyl chlorid as a refrigerant in the production of local anesthesia. Within a short time it became very popular in both the medical and dental professions. When it was found that ethyl chlorid would produce local anesthesia, it caused the ether spray to be abandoned. Ethyl chlorid is more volatile, has a lower boiling point, will produce evaporation much quicker, and is far more pleasant to the patient than ether.

The most efficient, highly volatile agents are ethyl chlorid, methyl chlorid, rhigolene, and carbon dioxid gas. These agents, when released from pressure from their container, at ordinary room temperature change rapidly to a gas. These agents were formerly manufactured abroad, especially in Switzerland and France, but within recent years they have been prepared in the United States, and their purity is equal to the imported compounds.

Ethyl chlorid is put up in 10 to 100 c.c. in either glass or metal containers. These tubes are very efficient because they contain a metal cap with a right angle tube, and when ready for use a small lever is raised which allows the ethyl chlorid to escape through a capillary opening. The anesthetizing power of highly volatile refrigerant agents is in inverse proportion to their boiling point and the lowering of the tissue temperature is caused by rapid absorption by the dissipation of heat. The intensity and rapidity of anesthesia depends upon the vascularity of the tissue. Tissue which is highly vascular is more difficult to anesthetize than tissue which is not vascular. It must be borne in mind that the compound sprayed upon the tissue has no definite therapeutic or narcotic action on the peripheral sensory nerves at the point where it is applied, but anesthesia is induced by the abstraction of heat from the tissues.

A temperature of 35° C. can be easily reached if ethyl chlorid is properly applied to the tissue. This rapid evaporation first causes an immediate reddening of the skin, rapidly followed by an area of whiteness which indicates that the skin is frozen. The spray should be held a distance of fifteen inches from the surface receiving the solution. If the operation is on a part in which the vascularity can be controlled, much better results will be obtained by the refrigerant method, because a deeper and longer anesthesia can be secured than in tissue that is vascular. When the anesthetic is applied to a part that is bloodless, or nearly so, great care should be exercised to prevent permanent injury.

In addition to ether, ethyl chlorid, and methyl chlorid, we have liquid nitrous oxid, liquid or solid carbon dioxid and liquid air. Liquid carbon dioxid is also known as carbon dioxid snow. These last-named compounds should never be used for anesthetic purposes. Carbon dioxid snow is used by dermatologists in the treatment of skin diseases. There have been placed on the market certain mixtures of ethyl and methyl chlorid in all kinds of proportions under the trade names of coryl, methethyl, anesthyl, which have been employed to a considerable extent in dental and oral surgery, as well as in general surgery. The production of local anesthesia through the medium of refrigerant agents has been attempted in numerous ways, but the compound which is the most popular is undoubtedly ethyl chlorid. Therefore, we will consider the practical application of this agent.

Local Anesthesia by Ethyl Chlorid.—The practical application of ethyl chlorid is of value, if it is used when indicated, and if the attempt is not made to secure anesthesia of deeper parts or of inflamed tissues. Ethyl chlorid is put up in such convenient form at the present time that the dentist or physician's equipment is not complete without it. It is a method that can be applied with practically no previous training; about the only thing that must be observed is an overfreezing of the tissue.

Disadvantages.—This method has five disadvantages which are as follows

1. Anesthesia is superficial, hence only minor operations can be performed.

2. If the ethyl chlorid has frozen the part, it is difficult to differentiate inflamed or diseased tissues from normal tissues.

3. The freezing of the tissues, especially if they are slightly inflamed, will cause pain.

4. If used in cases of pulpitis or acute pericementitis, it causes terrific pain.

5. It should not be used near an open flame.

Advantages.—The advantages of this method are summed up as follows:

1. Ease of application and convenience with which it can be given.

2. There is practically no danger connected with it, with the exception of overfreezing the tissues.

3. It quickly produces anesthesia of the mucous membrane and skin, if properly applied.

4. The anesthesia produced in superficial tissues makes it an efficient agent to eliminate the pain in the hypersensitive patient when inserting the needle at the starting point.

This method should not be used for exodontia operations, because the prolonged application of the anesthetic is often more painful than the operation itself, and there is really no indication for ever using it for such operations, for the reason that we have more efficient methods at our disposal, such as block anesthesia and nitrous oxid-oxygen anesthesia. The author speaks from experience when he makes this statement, because he had a tooth removed, and the pain caused from the application of the compound was far more excessive and, no doubt, lasted much longer than would have been the case if the tooth had been extracted without an anesthetic. The author advises that ethyl chlorid be used for operations which involve only the superficial structures.

Since the advent of nerve blocking there is no particular use for the ethyl chlorid spray other than to use it as a preliminary agent for rendering the mucous membrane anesthetic, and then it is only necessary in the hypersensitive or nervous individuals.

Technic.—The technic for applying ethyl chlorid to the mucous membrane of the skin is as follows: The Gebauer tube, which contains the ethyl chlorid, is equipped with a nozzle which is capable of allowing a small stream to escape. The stream is directed upon the part to be anesthetized and is held there until the tissue turns white and is covered with snow. It is well to apply vaseline to the tissues around the part to be anesthetized, and good practice to use gauze sponges as a packing to prevent the ethyl chlorid from running back into the throat. It is necessary to operate as quickly as possible while the anesthetic effect lasts, for it only takes a short time for the tissues to become normal.

CHAPTER VI

CLASSIFICATION OF NERVOUS SYSTEM

The great nervous mechanism in man is composed of two systems; *first,* the cerebrospinal, and *second,* the sympathetic, which are intimately connected. These two great nervous systems are divided again as follows:

CEREBROSPINAL NERVOUS SYSTEM	Cranial nerves Spinal nerves	Peripheral nervous system	
	Cerebrospinal axis	Brain Spinal cord	Central nervous system
SYMPATHETIC NERVOUS SYSTEM	1. Cranio-sacral part 2. Thoracico-lumbar part		

The neurones of the sympathetic by their position fall into two groups:

1. Central neurones, whose cell bodies lie in the brain and cord.
2. Ganglionic neurones, whose cell bodies are contained in the ganglia of cranial and spinal nerves and in the vertebral, prevertebral and terminal ganglia of the sympathetic system.

Sympathetic neurones are efferent and afferent in function; the efferent neurones innervate involuntary muscles and glands (and the sacroplasm of voluntary muscles—J. Ramsey Hunt); the afferent neurones supply viscera and probably the sacroplasm of voluntary muscles. The cerebrospinal nerves supply the disks or sacrostyles of voluntary muscles.

The division of the sympathetic into cranio-sacral and thoracico-lumbar parts is physiological rather than anatomical and has been determined by the response of these two parts to various drugs.

The cranio-sacral sympathetic includes the sympathetic neurones of the third, fifth, intermediate, ninth, tenth and eleventh cranial nerves, and of the second and third or third and fourth sacral nerves, together with their associated ganglionic neurones whose cell bodies lie in the ciliary, sphenopalatine, otic and submaxillary ganglia of the trigeminal nerve and in the ganglia of the cardiac, celiac, pelvic and other plexuses.

The functions of the cranio-sacral sympathetic are:

1. Pupillary constriction.
2. Accommodation for near vision.
3. Motor to tensors of palate and tympanic membrane.
4. Viscero-motor to muscle of trachea and bronchi, of lower esophagus,

stomach and intestine down to splenic flexure, and to longitudinal muscle of the rectum, bladder, uterus, etc.

5. Viscero-inhibitory to circular fibers of rectum, bladder, uterus, etc.
6. Cardiac inhibitory to ganglia of the heart.
7. Secretory to salivary glands and other glands of the mouth, throat, nose, orbit; trachea and bronchi; esophagus, stomach, liver, pancreas, etc.
8. Vaso-dilator to vessels of salivary and other glands.

Thoracico-lumbar sympathetic, called sympathetic proper because it contains the ganglionated sympathetic trunk, includes the sympathetic neurones of the thoracic and first two lumbar nerves which form the white rami communicantes, together with their associated ganglionic neurones, the cell bodies of which form the vertebral ganglia of the sympathetic trunk, the prevertebral ganglia of the cardiac, celiac and pelvic plexuses and other collateral and terminal ganglia.

GANGLIA OF SYMPATHETIC PROPER	1. Vertebral in sympathetic trunk (22-24).
	2. Prevertebral or collateral in cardiac, celic, pelvic and other plexuses.
	3. Terminal in organs, in circulatory, respiratory, alimentary and genito-urinary tracts.

The vertebral ganglia of the sympathetic trunk are divided as follows:

VERTEBRAL GANGLIA	3 Cervical	The ganglia are connected with the central nervous system by fibers called rami communicantes.
	9 to 12 Dorsal	
	4 to 5 Lumbar	
	5 Sacral	
	1 Coccygeal	

The function of the thoracico-lumbar system is as follows:

1. Cardiac accelerator.
2. Secretory.
3. Gastrointestinal inhibitory and motor.
4. Dilator to the pupil and palpebral fissure.
5. Pilomotor to the hair muscles.
6. Vasomotor to blood vessels.
7. Involuntary to muscles, as protrusor oculi.

The peripheral cerebrospinal nervous system is divided into:

12. Cranial nerves.

31 Spinal nerves.

Cranial Nerves.—

1. Optic, special nerve of sight.
2. Olfactory, special nerve of smell.
3. Motoroculi, a motor nerve to eyeball, supplying all striated muscles of orbit, except superior oblique and lateral rectus; its sympathetic fibers innervate the sphincter pupillæ and circular fibers of ciliary muscle.

4. Trochlear, motor nerve of eyeball, supplying the superior oblique muscles.

5. Trigeminus, the great sensory nerve of the head and face and motor to the muscles of mastication, the mylohyoid and anterior belly of digastric; and through the otic ganglion, it innervates tensor palati and tensor tympani.

6. Abducent, motor nerve to the eyeball, supplying the lateral rectus.

7. Facial, motor nerve to the muscles of expression, stapedius, stylo-hyoid and posterior belly of digastric.

Intermediate nerve. The intermediate nerve (glossopalatine nerve) is, first, a nerve of special sense, taste, to the tongue anterior to the circumvallate papillæ; common sensory to external meatus and a part of the auricle; and, second, a sympathetic-secretory and vaso-dilator to the spheno-palatine and submaxillary ganglia, (and probably the otic) through which the submaxillary and sublingual and salivary glands (and probably the parotid) and other glands of the mouth, throat and nose are innervated—

8. Auditory, to the internal ear for the special sense of hearing and equilibrium.

9. Glosso-pharyngeal, sensory nerve and nerve of taste, to the mucous membrane of the fauces and base of the tongue, and secretory and vaso-dilator to parotid gland and small glands of the mouth and tonsils; motor, to stylopharyngeus.

10. Vagus, a motor and sensory nerve supplying sensory and motor fibers to organs of voice and respiration and the soft palate, the pharynx, esophagus, stomach, motor to intestines and inhibitory to heart. Secretory and vaso-dilator to respiratory and alimentary glands.

11. Spinal accessory, a motor nerve to the sternomastoid and trapezius muscles.

12. Hypoglossal, the motor nerve of the tongue supplying all muscles of the tongue, except glosso-palatinus.

The cranial nerves may be classified as follows:

1. SPECIAL SENSE	Olfactory, special function	smell,
	Optic, " "	sight,
	Auditory, " "	hearing and equilibrium,
2. MOTOR	Motor oculi	
	Trochlear	
	Abducens	
	Facial	
	Spinal accessory	
	Hypoglossal	
3. MIXED	Trigeminal	
	Intermediate	
	Glosso-pharyngeal	
	Pneumogastric or vagus.	

The spinal nerves are divided as follows:

8 Cervical. The anterior divisions of the upper four form the cervical plexus; the anterior division of the lower four together with that of the first

dorsal form the brachial plexus. The posterior divisions supply muscles and skin of the back of the neck and occiput.

12 Dorsal. Their posterior divisions pass backward between the transverse processes and divide into the medial and lateral branches supplying the muscles and integument of the back. Their anterior divisions, called the intercostal nerves, are distributed to the wall of the thorax and abdomen. Their visceral branches, as white rami communicantes, enter the sympathetic trunk.

5 Lumbar. The posterior divisions pass backward supplying the integument and muscles of the back, and integument of the gluteal region. The anterior divisions of the upper four form the lumbar plexus. Visceral branches from the first two enter the sympathetic trunk as white rami communicantes.

5 Sacral. The posterior divisions supply the skin and muscle of the back and the skin of the gluteal region. The anterior divisions communicate with the sacral ganglia of the sympathetic, and the second and third give off visceral branches to the pelvic plexuses of sympathetic; those of the three upper sacral with the lumbo-sacral cord and a branch from the fourth sacral unite to form the sacral plexus which supplies the pelvic viscera and various muscles, perineum and lower extremity.

1 Coccygeal. Supplies muscles and skin in the immediate region.

Every spinal nerve may give off a meningeal branch to the meninges of the cord, and each one receives a gray ramus communicans from the sympathetic trunk, which supplies smooth muscles and glands along the nerve's distribution.

NEURONE

A neurone is the histologic unit and the highly specialized element of the nervous system. The system is composed of thousands and thousands of these minute divisions of nerve tissue. A neurone is defined as the nerve cell, a cell body, with all its processes. It is the anatomical and physiological unit which serves both for the evolution and conduction of nervous energy. All neurones which functionate are composed of a cell-body, an axone and one or more dendrites. All axones have the function of carrying impulses away from the cell-body of the neurone; therefore, they are cellifugal in their conduction. The dendrites, on the other hand, transmit the impulses to the cell-body and are therefore cellipetal in function. The dendrites terminate in fine points in contact with the end arborization of other neurones, or with cells of end organs from which they receive impulses. The entire nervous system is a mass of neurones which are very closely packed together and are in constant communication with each other, but never directly continuous. A nerve fiber, axone, or dendrite, from one cell never anastomoses with that of another, as is the case with blood vessels. Each neurone is anatomically independent and its function is to receive impulses from within or without the body and to modify and transfer them; and, second, to send out impulses in such a manner as to properly control the vital function and keep the individual in proper harmony with his environment. The nervous mechanism of the human body is a great regulating, controlling and discharging machine; the neurones constitute the parts of the machinery; and the force which works this machinery is called nervous energy. This great system of nervous mechanism is divided into (1) the cerebrospinal system, embracing the central axis with all of its peripheral nerves, the cranial and spinal; and (2) the autonomic or sympathetic nervous system.

TRACTS AND NERVES

We note from the researches which have been made within recent years in neural anatomy, that the origin of a central nerve tract is from a nerve center or centers, which may be separated at a considerable distance from each other. The tracts and nerves which run between nerve centers and end organs may transmit impulses each way and are divided into afferent, centripetal, or ingoing and efferent, centrifugal or outgoing. The efferent tracts rise in motor cortex and basal nuclei; the efferent nerves get their origin in the motor nuclei of cranial and spinal nerves and pass to the periphery dividing up into numerous small branches supplying muscles, etc.

The afferent nerves of the cerebrospinal system rise in the ganglia of the spinal and cranial nerves; afferent tracts rise in these same ganglia and in the nuclei of the cord, medulla, pons, cerebellum, midbrain and interbrain; the afferent paths formed by these tracts terminate in the thalamus and in the common sensory and special sensory cortex of the cerebrum. The afferent or sensory nerves are divided into the nerves of general sensation and the nerves of special sensation. The nerves of general sensation are those for transmitting impulses of pain, heat, cold, touch, pressure, tension, localization, position and movement, and the nerves of special sense are those of sight, smell, taste, hearing and equilibrium.

The peripheral nervous system is endowed with end organs. The end organs of efferent nerves are muscles and glands. Their object is to allow the proper utilization of efferent impulses in different parts of the body. The receptive end organs, end organs for afferent nerves, such as the eye, ear, terminal corpuscles, etc., have for their object adaptation to particular stimuli and lowering of the threshold of adequate stimulus. The end organs are delicate and in some cases complex arrangements of nervous and other tissue at the periphery of the nerve. In some cases, the end organ is nothing but the terminal fiber of the nerve which is void of a medullary sheath and neurilemma, nothing being left but the axis-cylinder which forms a plexus that arborizes around and between the cells.

An efferent nerve is one which carries impulses to the periphery. The efferent nerves are divided into three classifications, which are as follows:

First, motor nerve which supplies voluntary or striped muscle, heart muscle, food muscle, which includes the vaso-constrictor and vaso-dilator nerve by which blood pressure is controlled. *Second*, the secretory nerve which acts upon glands and, *third*, the inhibitory nerve which controls muscular movement and secretion.

The afferent peripheral nerve fibers arise in cranial and spinal ganglia. They terminate distally in end organs, which are capable of taking up various impressions, and they conduct the impulses towards the brain. The afferent nerve serves the purpose of conducting impulses which arouse sensation and reflex action. The afferent fibers form connections with special end organs, such as end bulbs of Krause, tactile and pacinian corpuscles, the retina, the spiral organ of Corti, etc. These end organs are capable of taking up various impulses which are carried over the afferent fibers to the brain and both excite reflexes and induce sensations. Every dentist is familiar with the sensi-

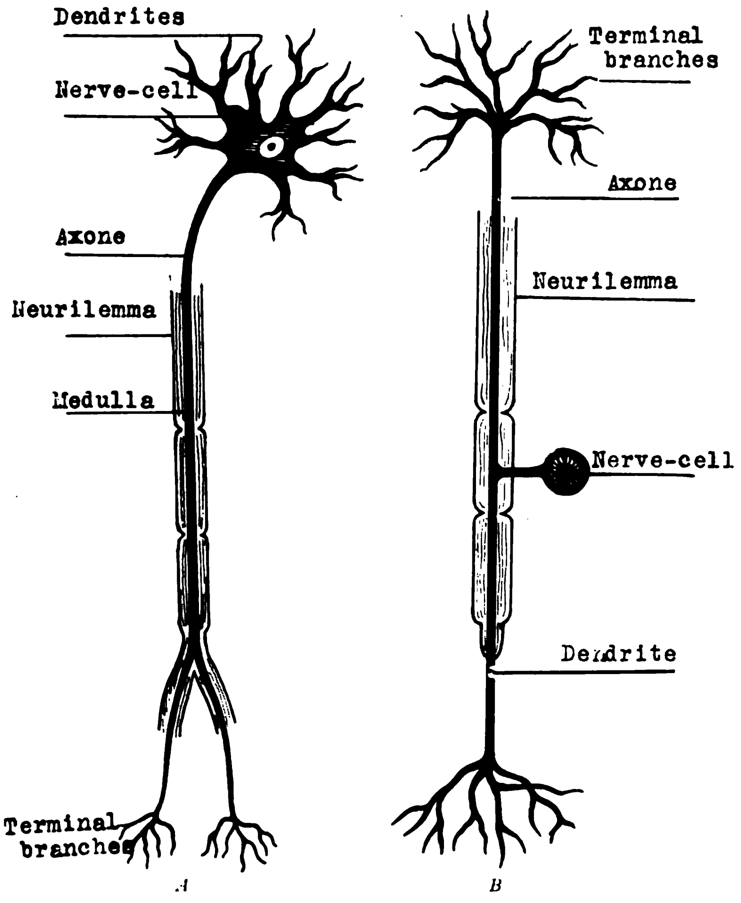


Fig. 15.—An efferent neurone and an afferent neurone. *A*, Efferent neurone; *B*, afferent neurone. (Redrawn from Brubaker.)

tiveness of the dento-enamel junction of a tooth. The cutting of the tooth at enamel junction, therefore, causes more pain than when the cutting is nearer the pulp. The cutting, burring or chiseling sensation is transmitted to the odontoblasts, then to the dental pulp and over the various afferent fibers to the sensory area in the brain.

THE NERVE

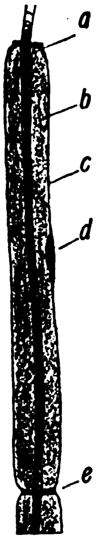


Fig. 18.—Longitudinal fiber, diagrammatic: *a*, axis-cylinder; *b*, medullary sheath; *c*, neurilemma; *d*, nucleus; *e*, node of Ranvier (Leroy).

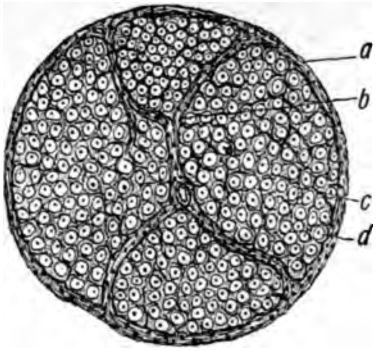


Fig. 16.—Transverse section of a nerve: *a*, epineurium; *b*, perineurium; *c*, endoneurium; *d*, section of a single fiber (Leroy).*

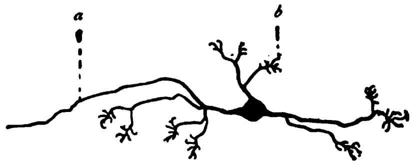


Fig. 19.—Nerve-cell with dendrites ending in claw-like telodendria. *a*, neuraxis; *b*, telodendrion.

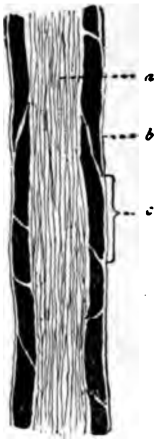


Fig. 17.—Longitudinal section through a nerve-fiber: *a*, fibrils of axis-cylinder; *b*, neurilemma; *c*, segments of Lantermann.

A nerve is defined as a cord-like structure which has the power to convey impulses from one part of the body to the other. Therefore, a nerve transfers impulses, both afferent and efferent, to various parts of the body and regulates the activity of all organs and muscles. A nerve consists of a connective tissue sheath, called the epineurium, which surrounds the entire nerve and incloses bundles of nerve fibers called funiculi; each bundle is in turn surrounded by its own sheath, called perineurium, and these various bundles or funiculi are again separated or divided by septa of connective tissue, each called endoneurium. Each white fiber is made up of an axis-cylinder, a medullary sheath, and a surrounding neurilemma. The medullary sheath of the nerve fiber is interrupted at intervals of about one mm. by annular constrictions which are called the nodes of Ranvier, and each segment included between two nodes has a neurilemma nucleus which is situated on the inner surface of the neurilemma. The axis-cylinder which is surrounded by the medullary sheath, continues throughout the length of the nerve fiber; it is the essential part of the nerve fiber and every axis-cylinder is to be regarded as a prolongation of the axone of some nerve cell or the dendrite of a bipolar neurone.

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*Figs. 16, 17, 18, and 19 are reproduced from the American Illustrated Medical Dictionary.

A nerve may contain at least two kinds of fibers, the medullated and the non-medullated. The non-medullated are called grey fibers; they consist of an axis-cylinder, or central core, inclosed in a nucleated sheath. The non-medullated fibers compose the sympathetic nerves; however, this type is found in many nerves of the cerebrospinal system. The medullated or white fibers contain an axis-cylinder, the most essential part of the nerve fiber, and a direct prolongation of the nerve cell, the white substance of Schwann and a neurilemma. The segmented myelin sheaths are subdivided by clefts called the Schmidt-Lanterman lines.

The neurilemma surrounds the axis-cylinders of all peripheral nerves, except the optic and olfactory nerves. The neurilemma is not found within the brain and spinal cord; it separates the segments of myelin at the constrictions called nodes of Ranvier. The myelin sheath is composed of fatty material which acts as an insulator and protects the axis-cylinder. When a nerve trunk divides into branches the connective tissue which surrounds the nerve follows its various branches, and when the nerve trunk finally becomes divided to a point where it is just a single fiber, the perineural and endoneural connective tissue sheath still remains and is called the sheath of Henle.

NERVE DEGENERATION

In 1850 Waller discovered that a nerve fiber which is severed from the cell body out of which it grew, would sooner or later undergo degeneration. This has been called Wallerian degeneration and is evident within forty-eight hours after section and is almost complete by the fourteenth day. Wallerian degeneration consists of the disintegration of the myelin into droplets and globules of granular lipoid substances, and the breaking up and a gradual disappearance of the nerve fiber. Later the myelin debris is absorbed. In the case of a peripheral nerve, which is endowed with a neurilemma, there is proliferation of the nuclei of the neurilemma, and the formation of a band fiber, which guides the cone of growth in regeneration. It has been found that the part of the fiber which is connected with the cell body, that is, the central stump, does not suffer degeneration, it being only the peripheral portion which is severed from the central part. In case a peripheral nerve is severed the central stump will very soon show evidence of regeneration; but, in case the location is within the brain or spinal cord, regeneration does not take place with any degree of success in man and, instead of having regeneration, the opposite takes place, as signs of degeneration slowly appear in the cell body soon after the injury and this is called **Nissl degeneration.**

NERVE REGENERATION

In case a neurone or nerve fiber is destroyed in man, it is not replaced by proliferation of other neurones or nerve fibers, as the remaining nerve substance does not exhibit mitotic or direct division. However, it is a well

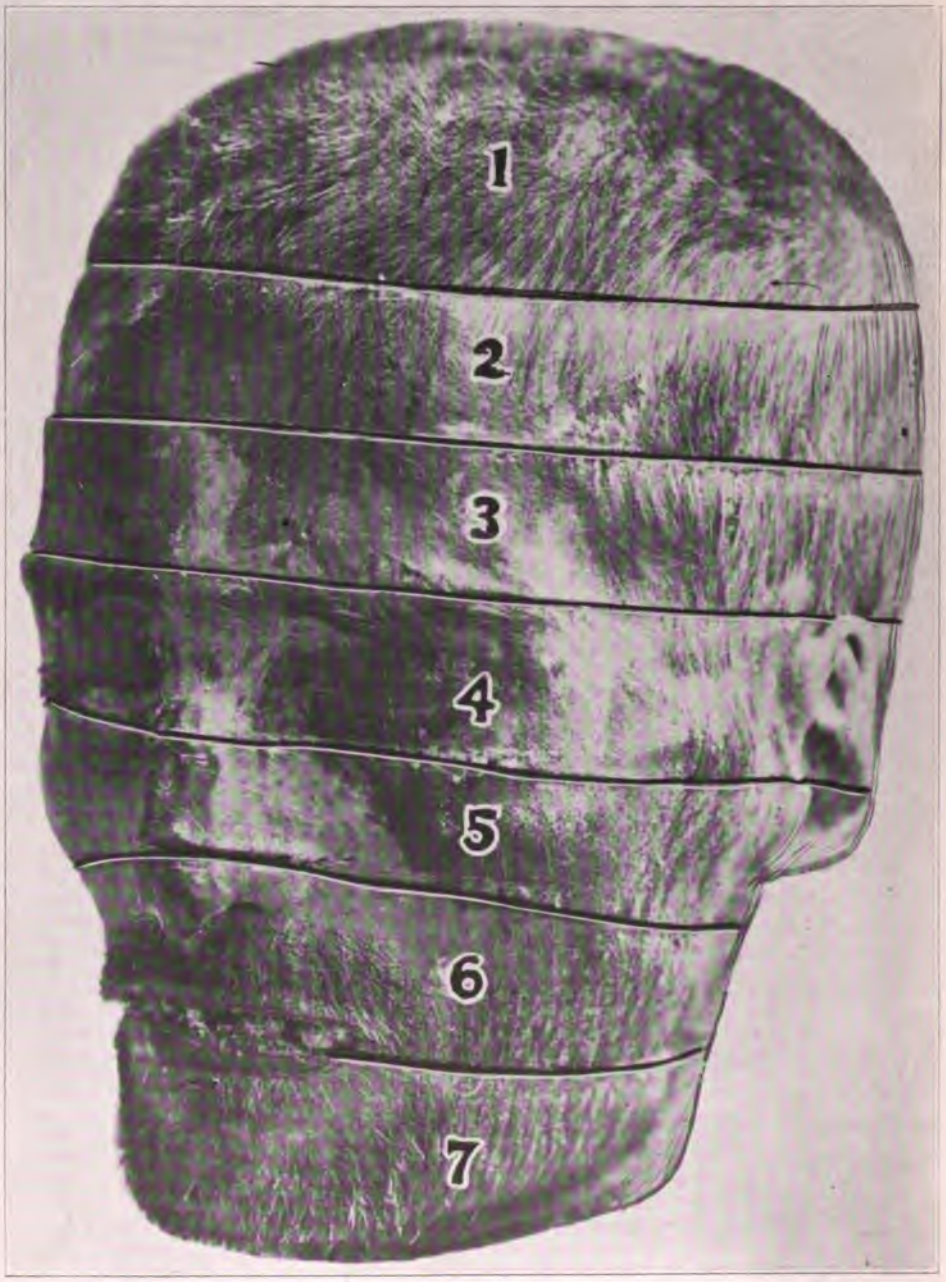


Fig. 20.—Wet anatomical specimen showing seven cross sections at various levels.

known fact that regeneration of a nerve may follow the cutting of it; this no doubt has been experienced by many oral surgeons who have performed nerve resection in the treatment of tic douloureux. The regeneration of a nerve fiber is now known to be similar to its original formation and the process through which it goes is as follows:

A soft mass, the cone of growth, forms on the distal end of the central stump at the point of severance, or in other words, on the part which is connected with the cell body. This soft substance which is in the form of a cone

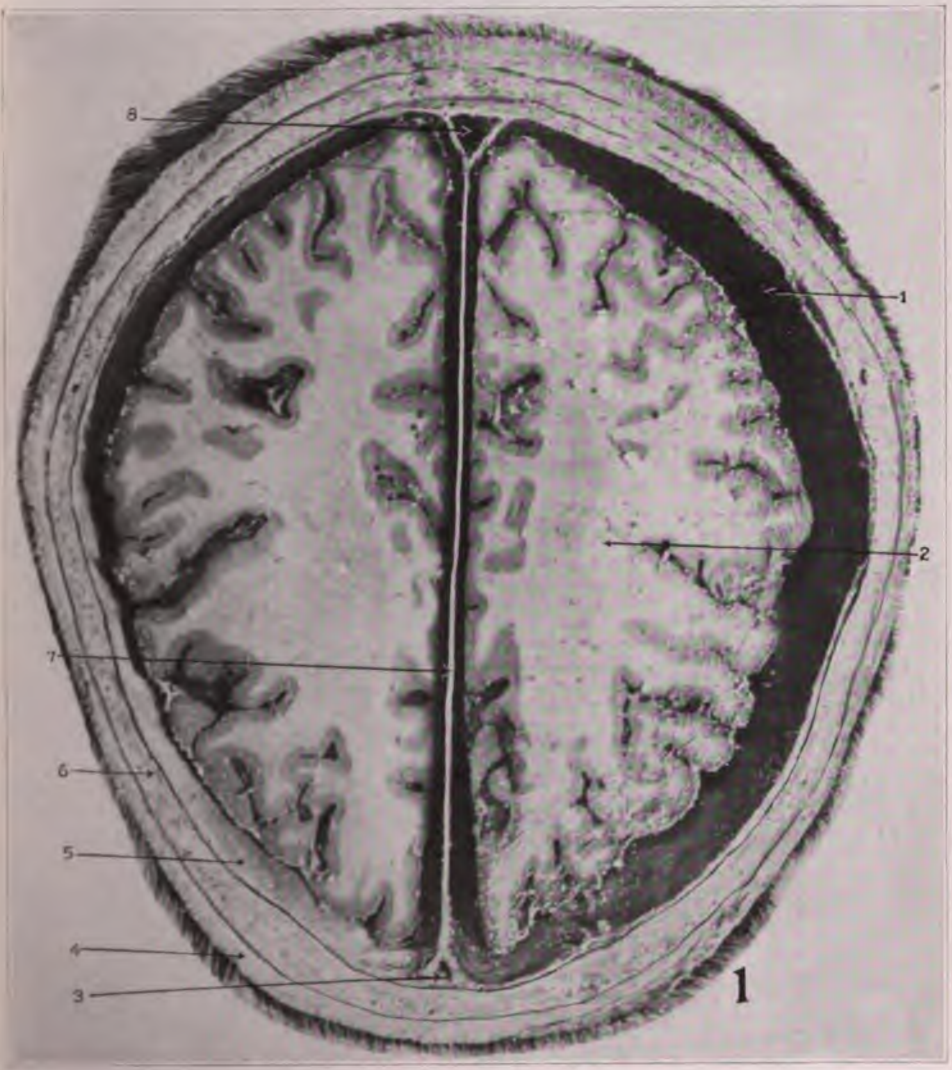


Fig. 21.

1, Subarachnoid space; 2, centrum semiovale of cerebrum; 3, superior sagittal sinus (anterior part) in falx cerebri; 4, scalp; 5, dura mater; 6, cranial bone; 7, falx cerebri and 8, superior sagittal sinus (posterior part).

grows peripherally, following the band-fiber developed from the neurilemma and gradually fills the location of the original fiber. The regeneration of a nerve fiber seems to be governed by some strong neurotropic force. Such force seems to be located in the neurilemma cells which formerly surrounded the primary nerve.

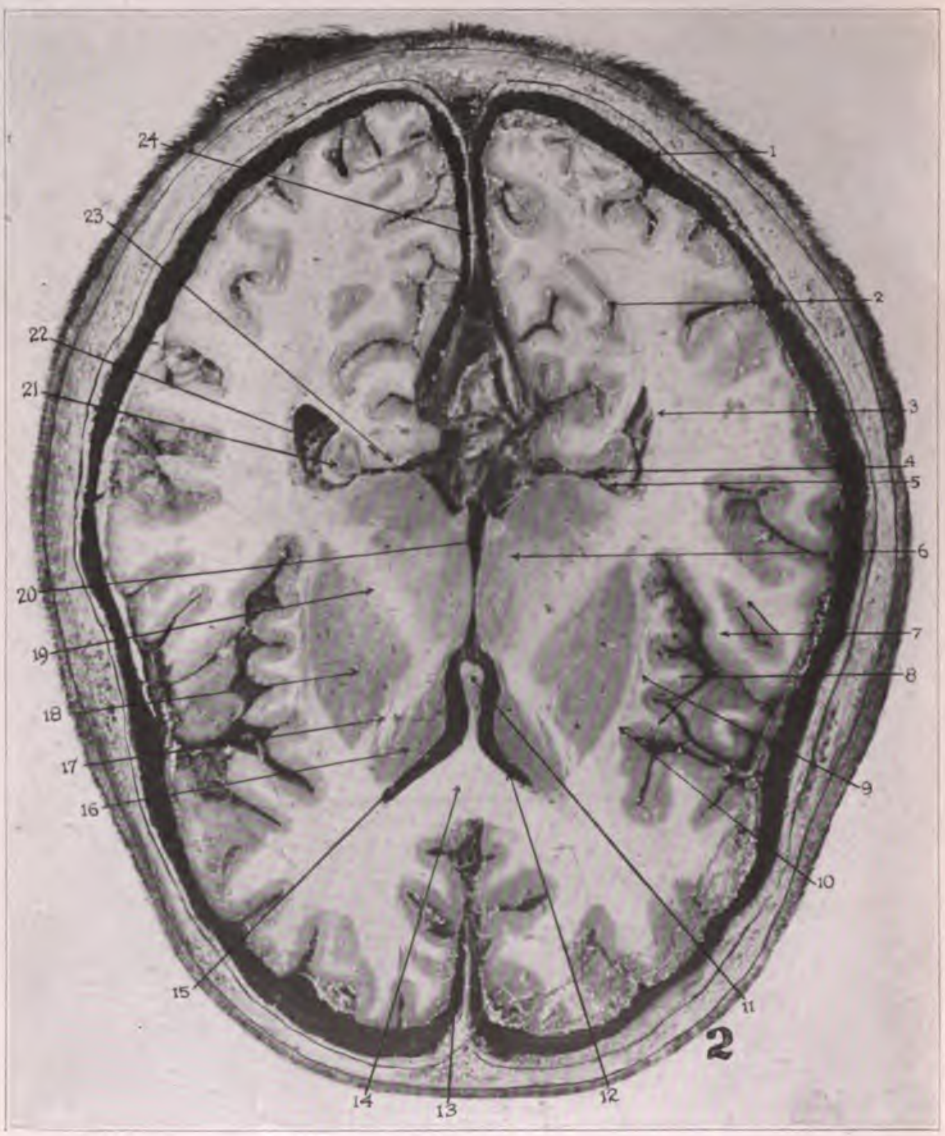


Fig. 22.

1, Dura mater; 2, calcarine fissure and visual cortex; 3, optic radiation; 4, dentate fascia; 5, crus of fornix; 6, thalamus; 7, transverse temporal gyri (auditory); 8, gyri of the island of Reil; 9, claustrum; 10, external capsule; 11, fornix; 12, anterior horn of lateral ventricle; 13, falx cerebri; 14, splenium of corpus callosum; 15, septum pellucidum; 16, caudate nucleus of corpus striatum; 17, frontal part of internal capsule (superior lamina); 18, leutiform nucleus of corpus striatum; 19, occipital part of internal capsule (superior lamina); 20, third ventricle; 21, hippocampus; 22, glomus choroideum in inferior horn of lateral ventricle; 23, gyrus hippocampi; 24, falx cerebri.

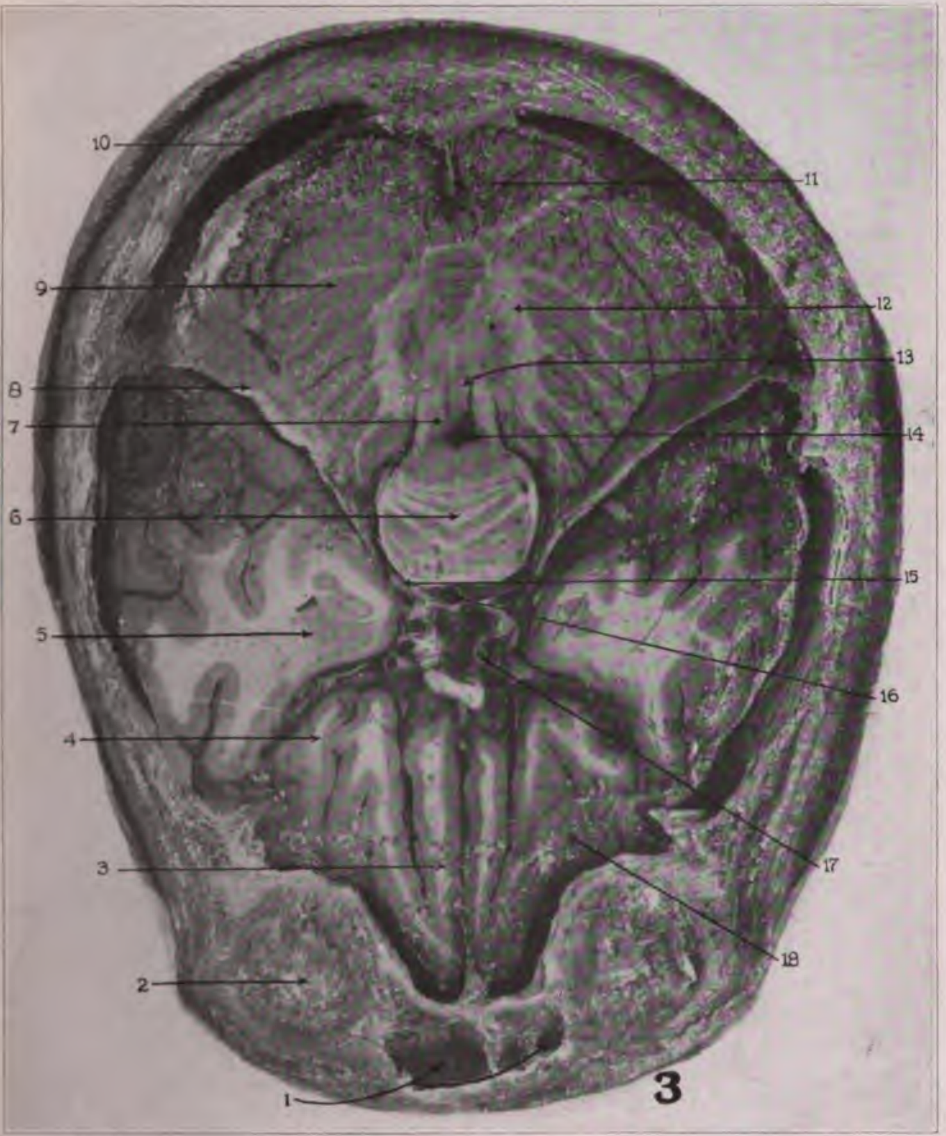


Fig. 23.

1, Frontal sinuses; 2, orbital contents; 3, gyvus rectus; 4, posterior orbital gyvus; 5, temporal lobe; 6, pons, basilar part; 7, brachium conjunctivam; 8, tentorium cerebelli; 9, cerebellar hemisphere; 10, subarachnoid space; 11, falx cerebelli; 12, corpus medullare of cerebellum; 13, superior (anterior) medullary velum; 14, fourth ventricle; 15, oculomotor nerve (third); 16, basilar artery; 17, internal carotid artery; 18, anterolateral orbital gyrus.

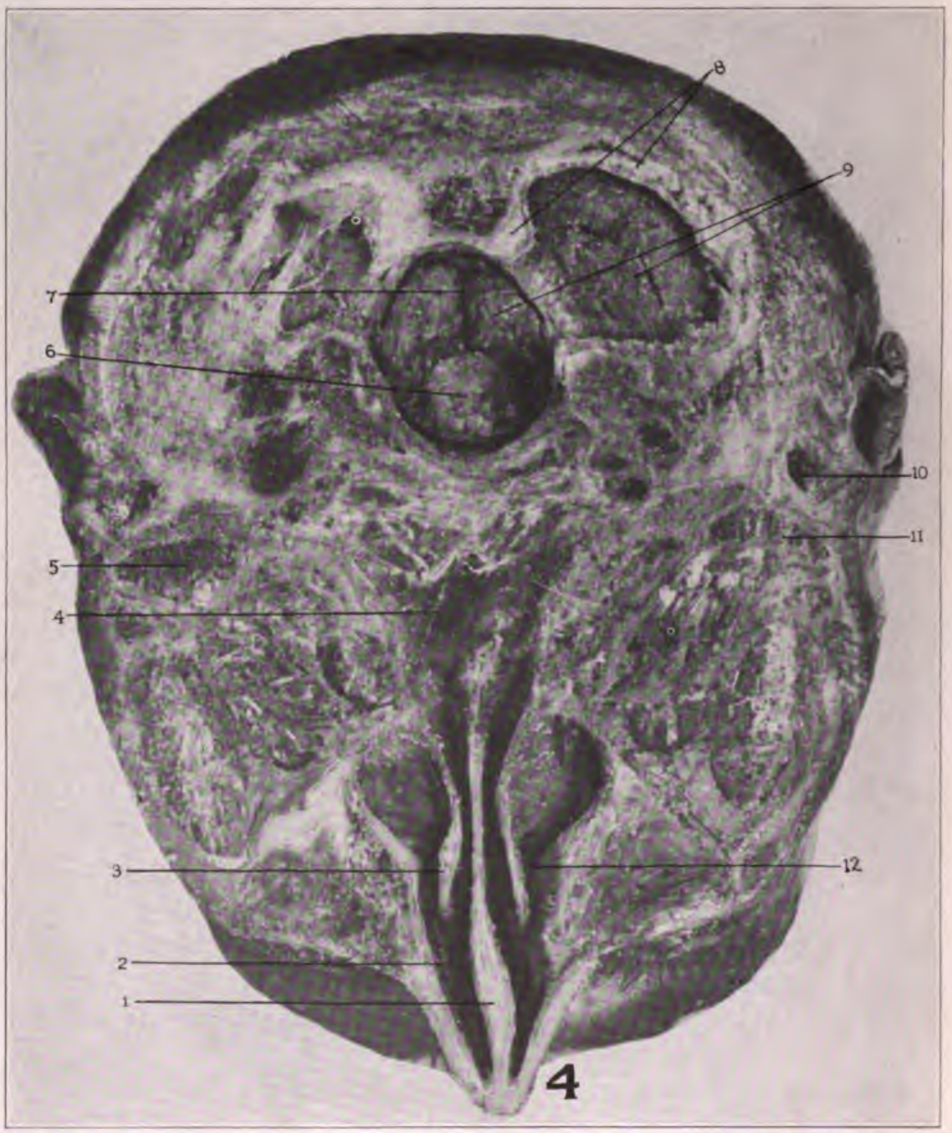


Fig. 24.

1, Nasal septum; 2, common nasal meatus; 3, middle concha or turbinate; 4, nasopharynx; 5, parotid gland; 6, medulla oblongata; 7, posterior notch of cerebellum; 8, section of occipital bone; 9, cerebellum; 10, external acoustic meatus; 11, parotid gland; 12, middle meatus.

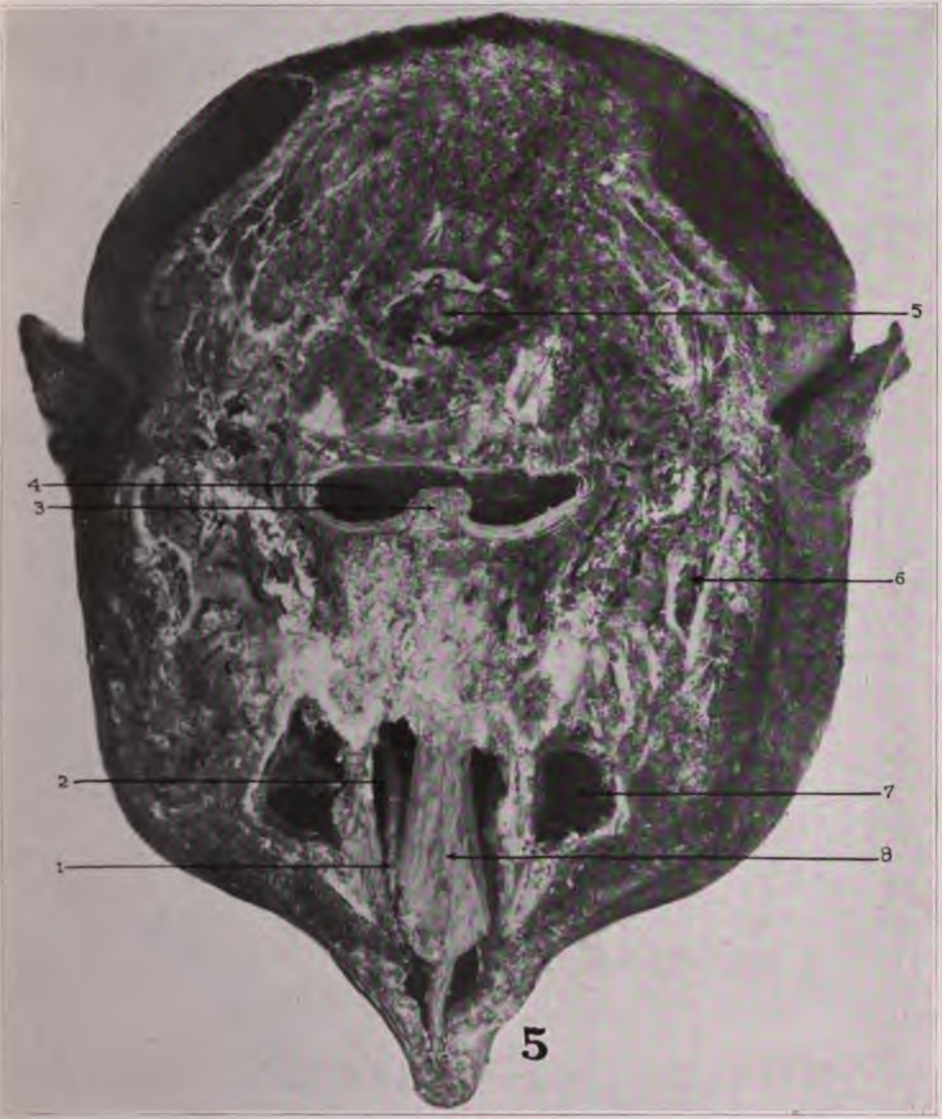


Fig. 25.

1, Inferior nasal concha; 2, inferior nasal meatus; 3, uvula; 4, nasopharynx; 5, spinal cord; 6, section of ramus of mandible; 7, sinus of maxilla; 8, nasal septum (thickened).

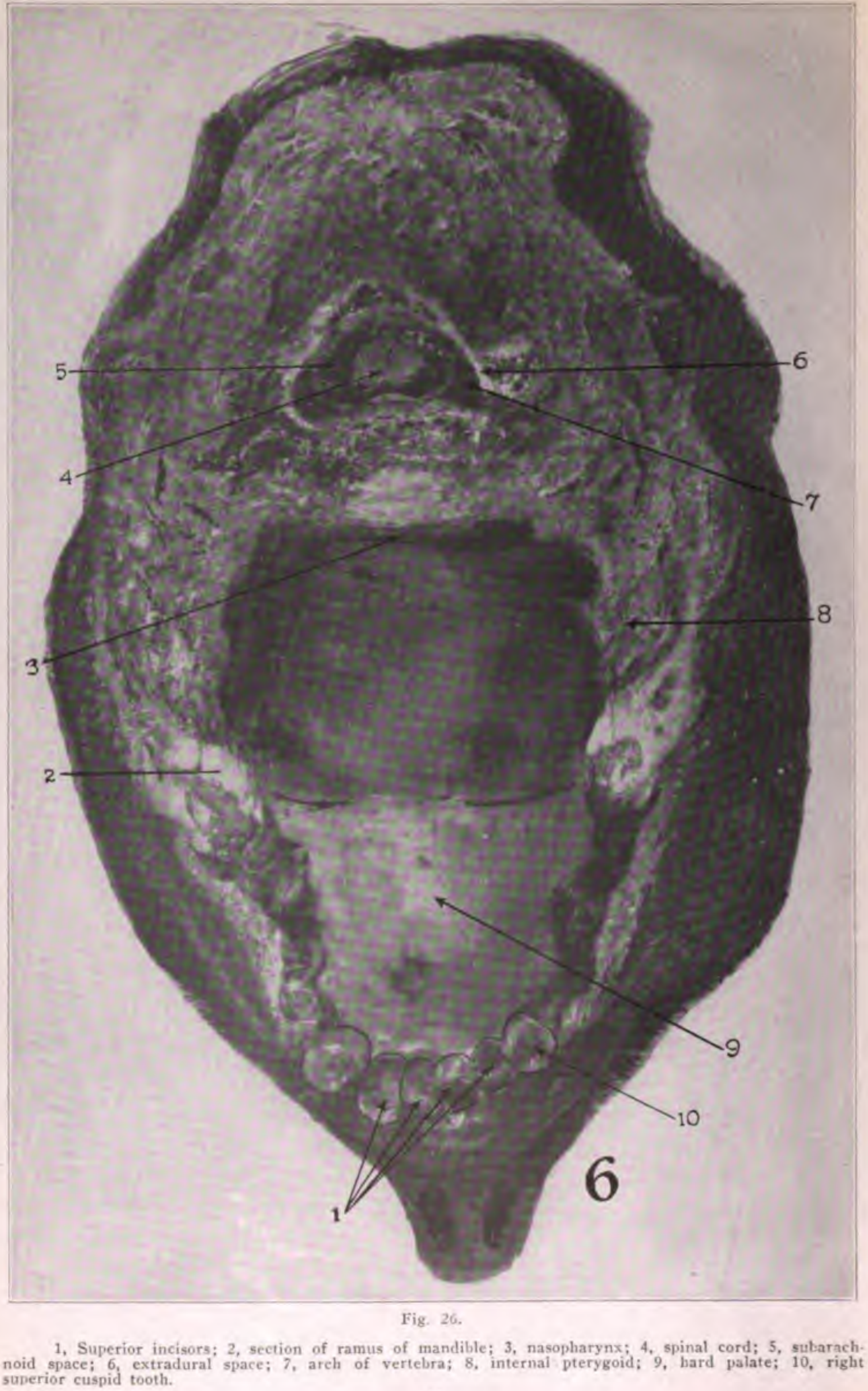


Fig. 26.

1, Superior incisors; 2, section of ramus of mandible; 3, nasopharynx; 4, spinal cord; 5, subarachnoid space; 6, extradural space; 7, arch of vertebra; 8, internal pterygoid; 9, hard palate; 10, right superior cuspid tooth.

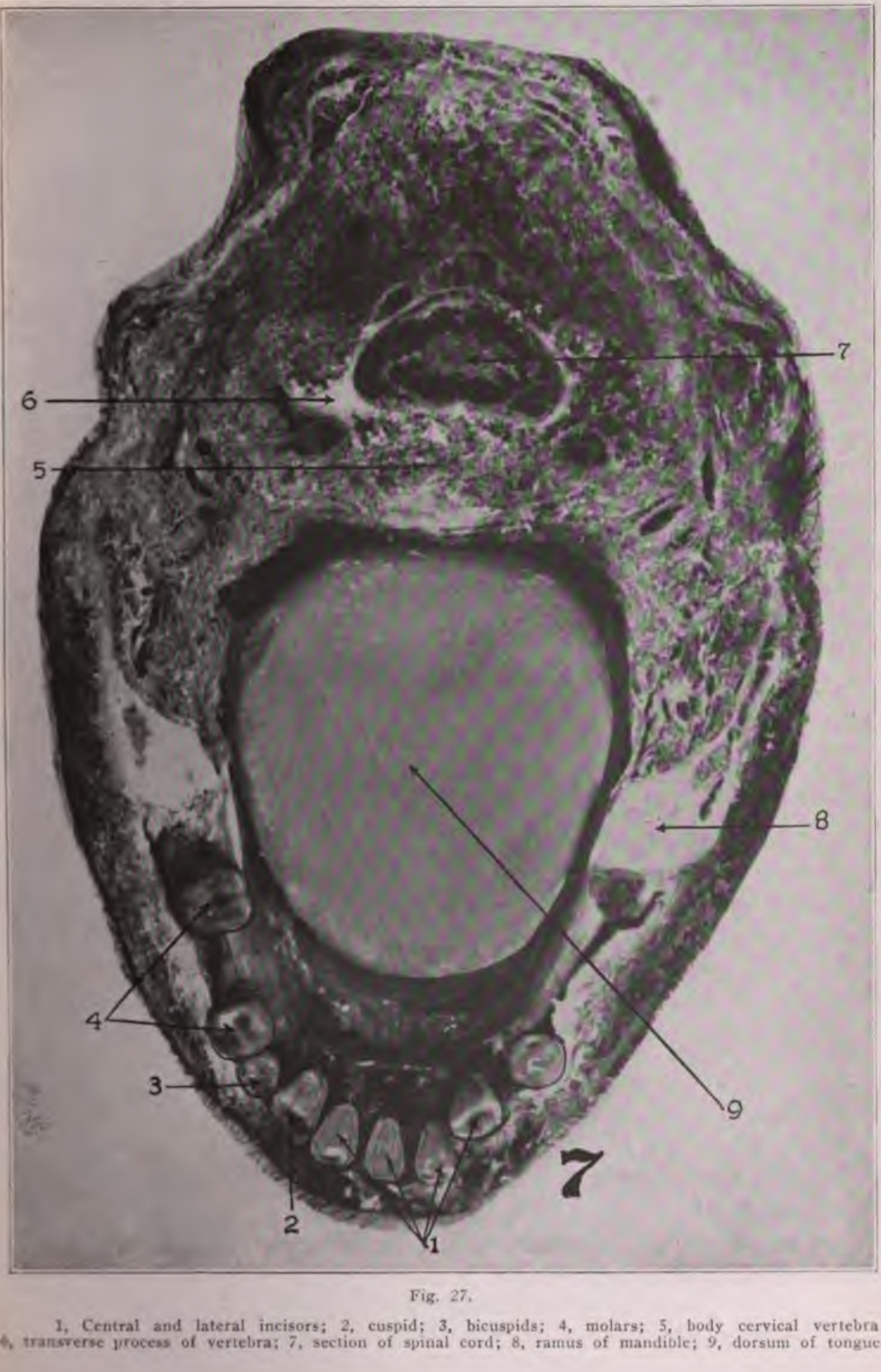


Fig. 27.

1, Central and lateral incisors; 2, cuspid; 3, bicuspids; 4, molars; 5, body cervical vertebra; 6, transverse process of vertebra; 7, section of spinal cord; 8, ramus of mandible; 9, dorsum of tongue.

CHAPTER VII

NERVUS TRIGEMINUS

Synonyms.—*Fifth Cranial Nerve; Trigeminal Nerve.*

Introduction.—The nervus trigeminus and its connecting branches with other nerves is considered the most difficult piece of nervous anatomy to master and understand. The location of this nerve with its extreme complexity requires considerable study to become perfectly acquainted with it in all of its phases. The reader, no doubt has gone through the same experience as the author at the time he was a student in college, in that more time was spent on this part of anatomy than any other part of the human body, and many times he looked forward with a little hesitancy on his ability to discuss thoroughly the nervus trigeminus and all its connecting links on the quiz or examination day. This cranial nerve is complicated and can be mastered only by diligent study and a thorough course in dissecting.

The author has given instruction to numerous study clubs, dental societies, and in various colleges, not only to students but to practitioners who have been in practice for years, and, with all due respect to his colleagues, it has been astonishing to see how much anatomy the dental practitioner has forgotten. Many have stated they never did possess a definite and thorough knowledge of the fifth cranial nerve and its connecting links with other nerves, while others have said that they at one time possessed a thorough understanding of it but had forgotten nearly all of the details.

In giving instruction on anatomy of the head, by lectures and by special dissection, which is the basis upon which a thorough knowledge of nerve blocking consists, quizzes were conducted, and in nearly all cases the practitioner did not possess a thorough knowledge of the complicated parts of the nervous system. The author does not wish to cast any reflection on, or to question the ability of any practitioner with reference to his knowledge of anatomy. However, he has had the pleasure of mingling with thousands of fellow practitioners, and is in a position to realize thoroughly that many of them need to review their anatomy before they attempt deep nerve blocking injections or enter the field of oral surgery.

A number of practitioners informed the author they had been practicing nerve blocking for fifteen or twenty years, and when questions were asked them as to their definite technic of procedure, their statements revealed that they were not practicing nerve blocking as it is understood today, but were simply making subperiosteal or submucous injections, as had been practiced almost since the time cocain was discovered as a local anesthetic. The reader

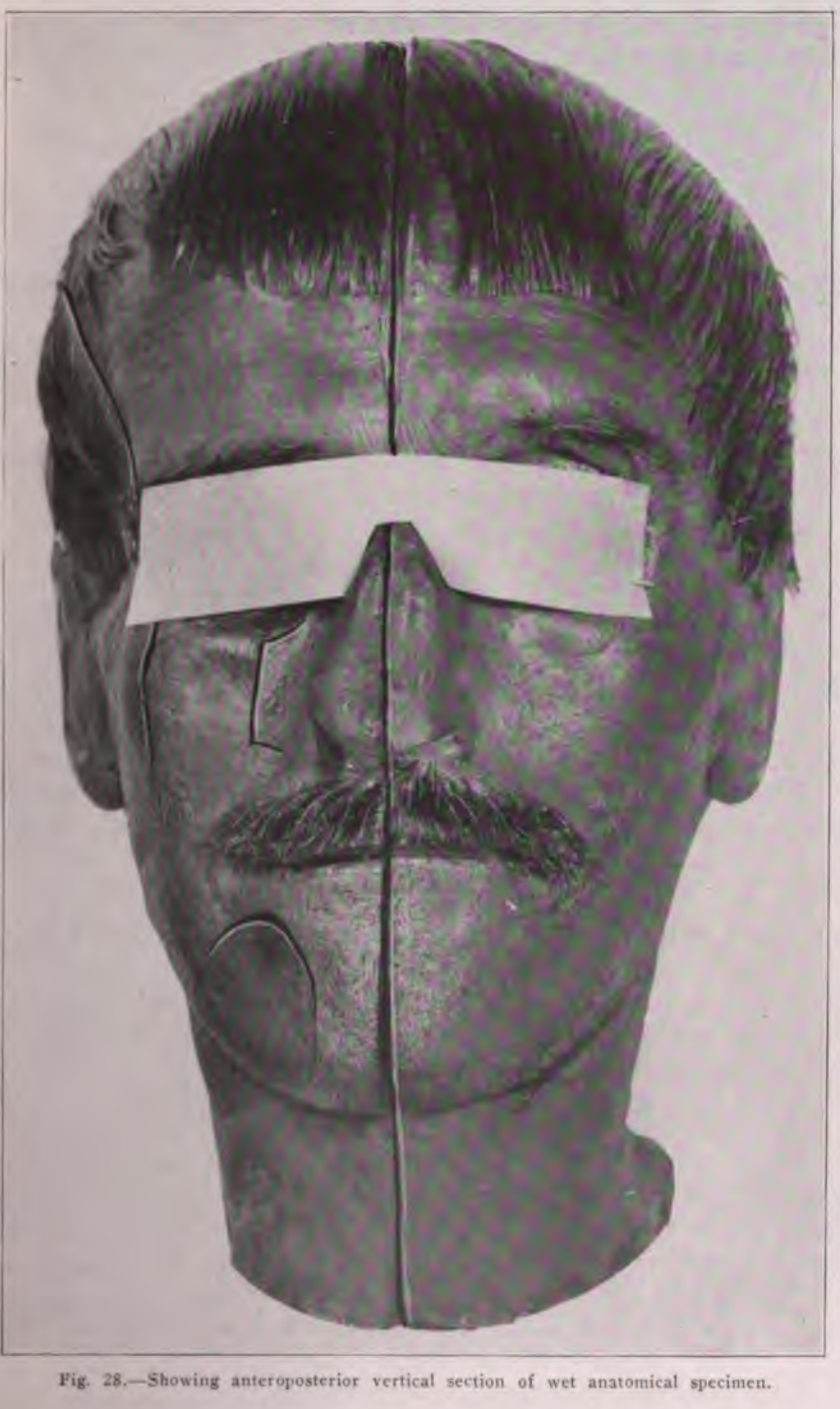
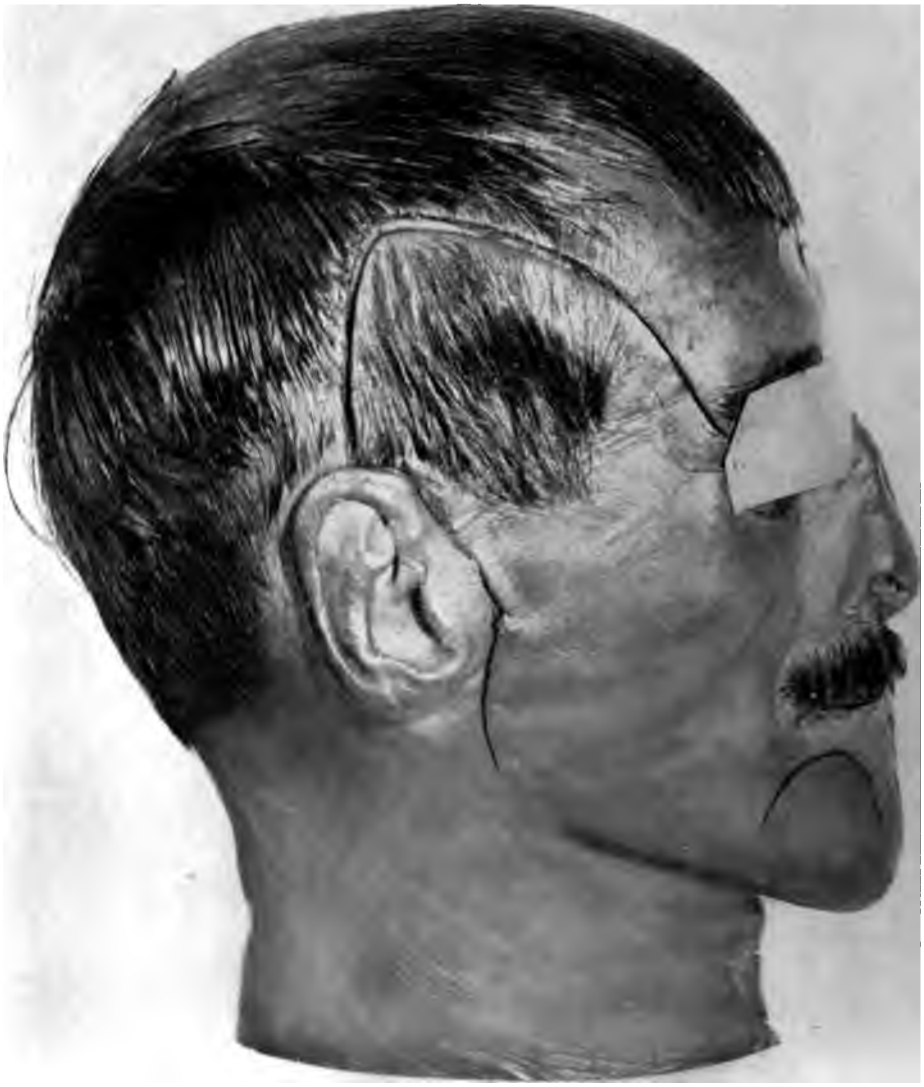


Fig. 28.—Showing anteroposterior vertical section of wet anatomical specimen.

will no doubt agree with the author, that it would not only be folly, but would be subjecting the patient to experimental procedure, for the practitioner, who is not thoroughly acquainted with the nerve branches and their location, to insert needles promiscuously into the tissues and inject a local anesthetic so-



[illegible]

[illegible] ssary, than that asepsis.
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locking injections, such as the blocking of the first, second, and third divisions of the fifth nerve, and their important branches, and the various ranches from the cervical plexus and cervical ganglia, it is imperative that he operator should have a thorough knowledge of nervous anatomy. The uccessful operator, with nerve blocking technic, has a clear mental picture

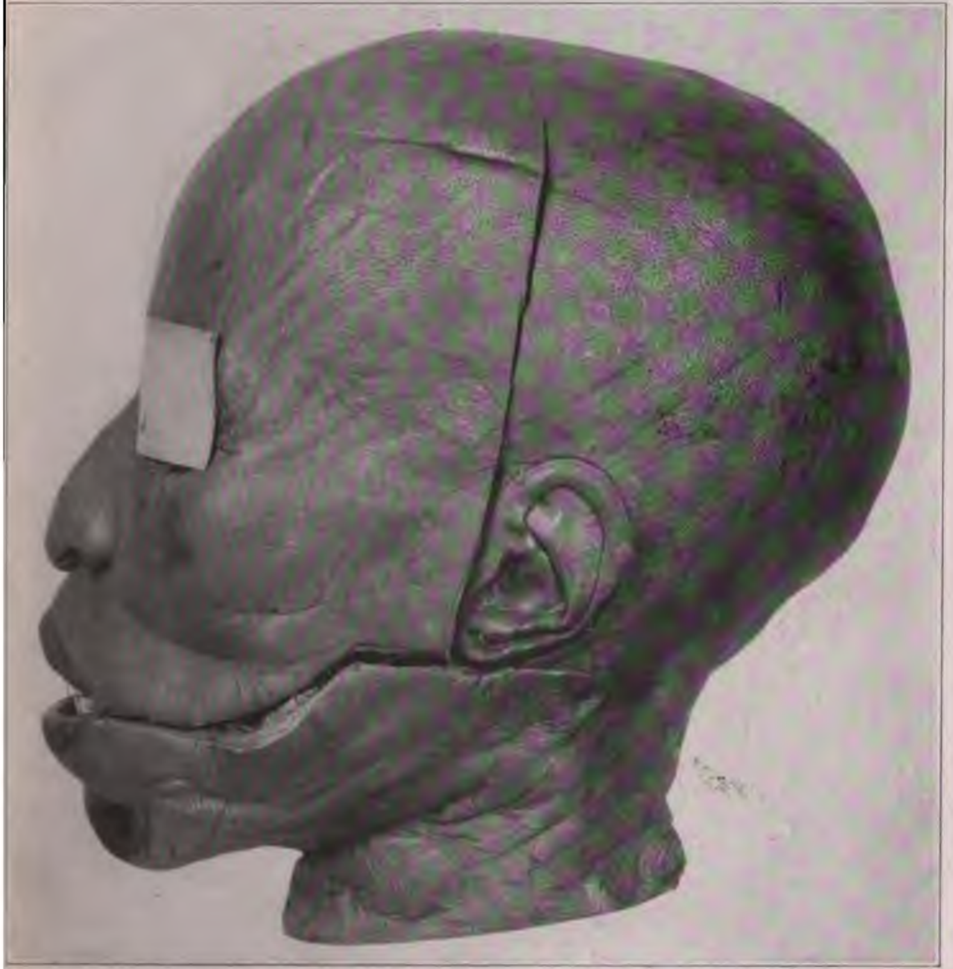


Fig. 33.—Wet anatomical specimen which has been incised posteriorly from angle of mouth to oint anterior to the ear and upward to vertex. All the soft tissues have been carefully separated from e bone in order to thoroughly expose the nerve branches and blood vessels.

f all those nerve branches which he blocks, and can easily outline them on aper or the blackboard.

The fundamental basis of nerve blocking is not only a thorough knowldge of nervous anatomy, but also of the surrounding anatomic structures, nd a knowledge of the bones located in the region of the various nerve branches. After the anatomy is mastered, next come the important factors which are essential to success, such as a definite technic, isotonic solution, asepsis, etc., and after all of these things have been mastered, nerve blocking will prove a pleasure to any operator.

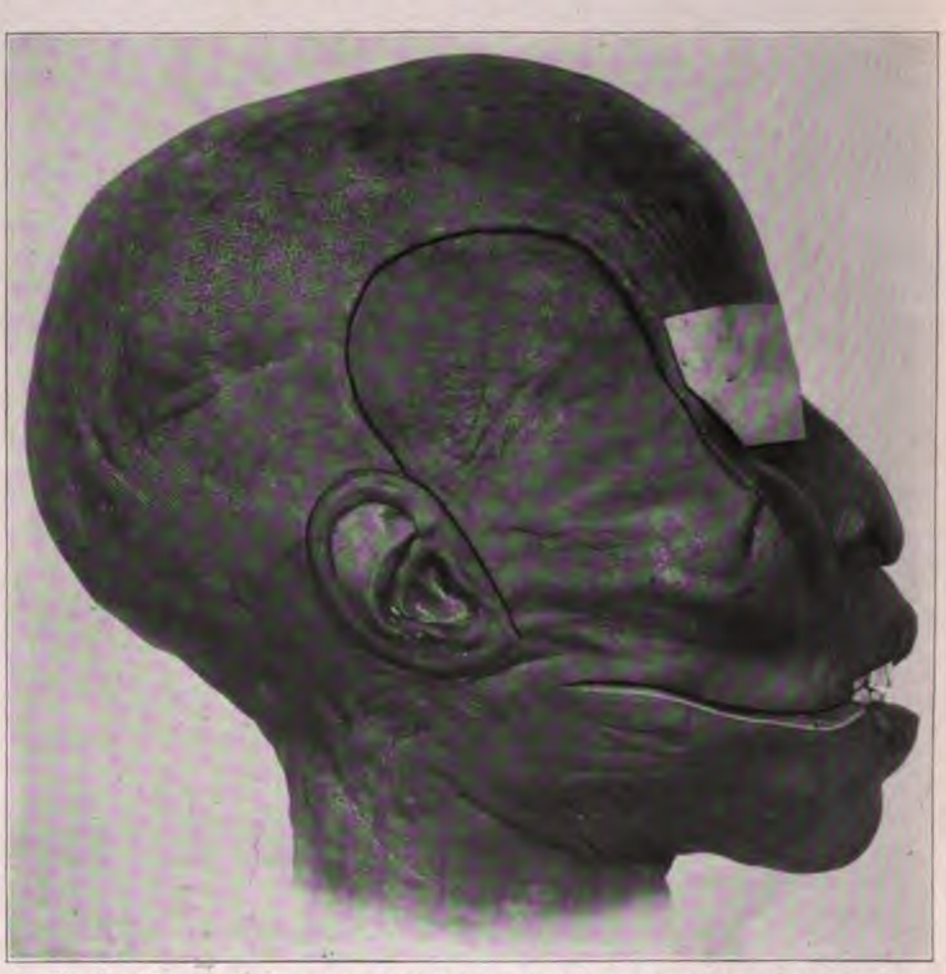


Fig. 31.—Wet anatomical specimen which has been incised from angle of mouth backward to ascending ramus, also from the external angular process of the frontal bone upward over parietal bone and inferiorly to the ear. All soft tissues have been carefully removed with the flap in order to expose the various nerves, blood vessels and other important structures located in the sphenomaxillary and infratemporal fossae.

Location of the Nervus Trigeminus

The location of the fifth cranial nerve is quite complex, its various branches being almost entirely surrounded and enclosed by bone. It passes anteriorly from the side of the pons Varolii (see Figs. 43 and 46) and its fibers course anteriorly beneath the base of the brain, in the middle fossa. The two roots, a sensory and a motor, course anteriorly in the posterior fossa of the skull, entering the middle fossa and extending to the Gasserian ganglion. This large

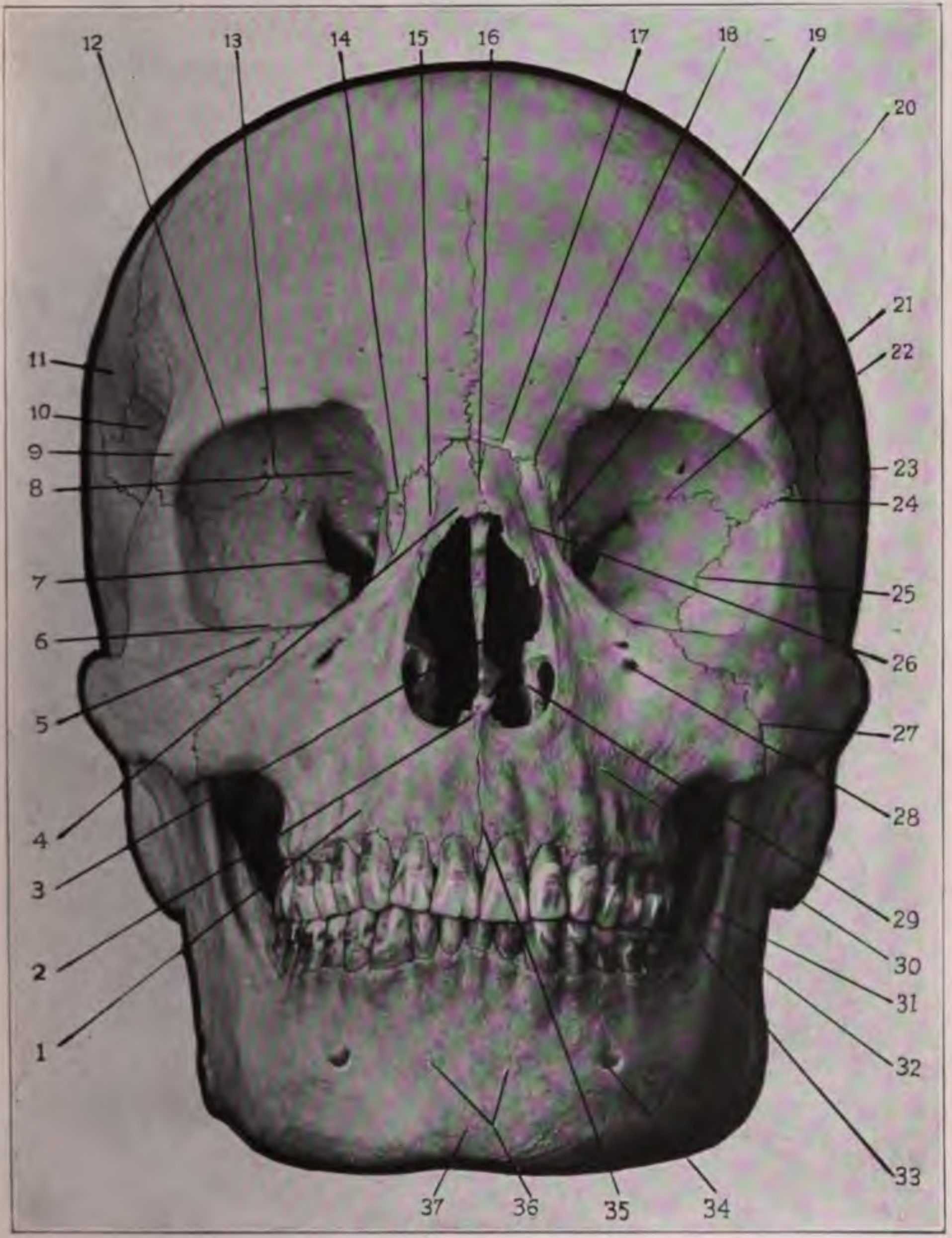


Fig. 32.

1, Alveolar process; 2, anterior nasal spine; 3, nasal septum; 4, nasal bone; 5, infraorbital margin; 6, infraorbital fissure; 7, sphenoidal fissure; 8, orbital plate of frontal bone; 9, zygomatic process; 10, greater wing of sphenoid; 11, parietal bone; 12, supraorbital margin; 13, sphenofrontal suture; 14, lacrimomaxillary suture; 15, frontal process of maxilla; 16, intranasal space; 17, nasofrontal suture; 18, frontomaxillary suture; 19, orbital surface of frontal bone; 20, lacrimal bone; 21, sphenofrontal suture; 22, sphenoparietal suture; 23, temporal bone; 24, zygomaticofrontal suture; 25, sphenozygomatic suture; 26, nasomaxillary suture; 27, zygomaticomaxillary suture; 28, infraorbital foramen; 29, inferior turbinated bone; 30, cuspid of fossa; 31, external oblique line; 32, internal oblique line; 33, retromalar triangle; 34, mental foramen; 35, intermaxillary suture; 36, incisive fossa and foramina; 37, symphysis.

ganglion is situated in an impression located on the apex of the petrous portion of the temporal bone (see Fig. 47) and is connected with three large nerve branches which are:

First, or ophthalmic, division.
Second, or maxillary, division.
Third, or mandibular, division.

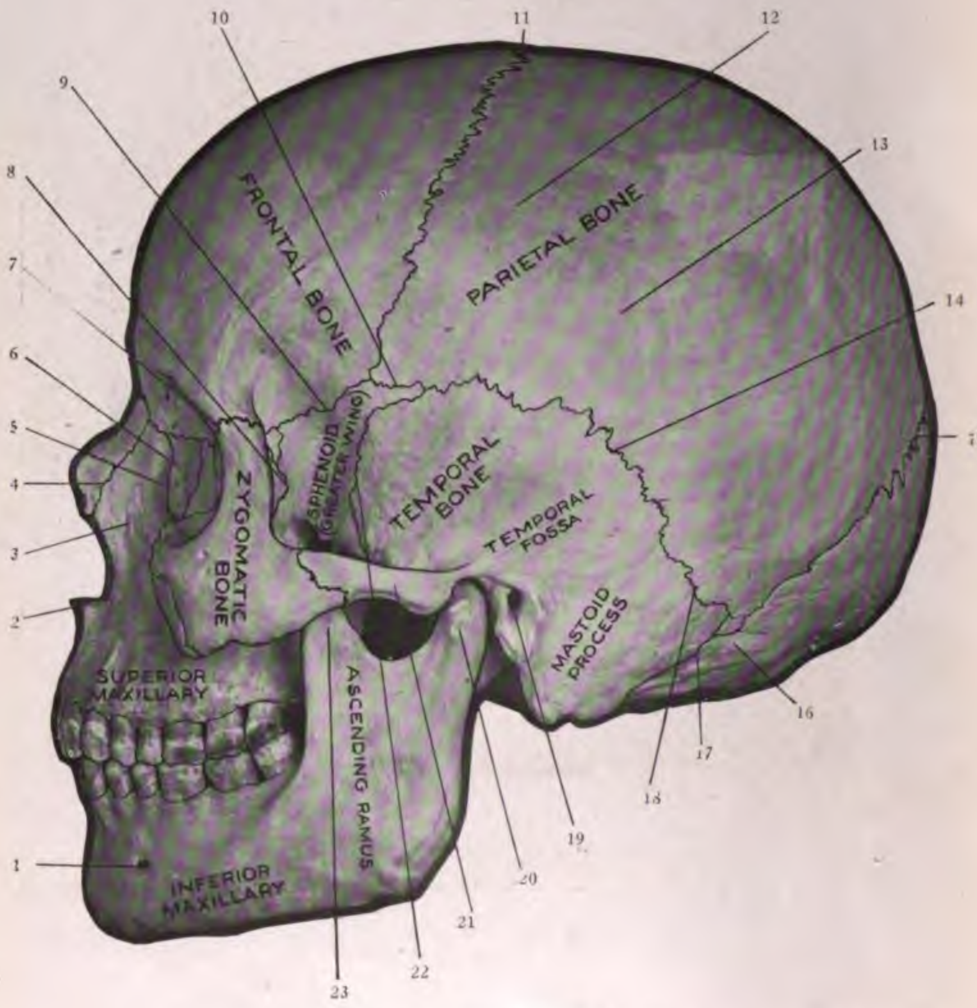


Fig. 33.—Skull seen from the left side.

1, Mental foramen; 2, anterior nasal spine; 3, frontal process of maxilla; 4, lachrymomaxillary suture, 5, nasomaxillary suture; 6, lachrymal bone; 7, zygomaticofrontal suture; 8, sphenozygomatic suture; 9, sphenofrontal suture; 10, sphenoparietal suture; 11, coronal suture; 12, superior temporal line; 13, inferior temporal line; 14, squamosal suture; 15, lambdoid suture; 16, occipital bone (squamous portion); 17, occipitomastoid suture; 18, parietomastoid suture; 19, external auditory meatus; 20, condyloid process of mandible; 21, zygomatic arch; 22, sphenosquamosal suture; 23, coronoid process of mandible.

Ophthalmic Division.—The first, or ophthalmic, division makes its exit through the superior orbital fissure (sphenoidal fissure) (see Fig. 55), and, in

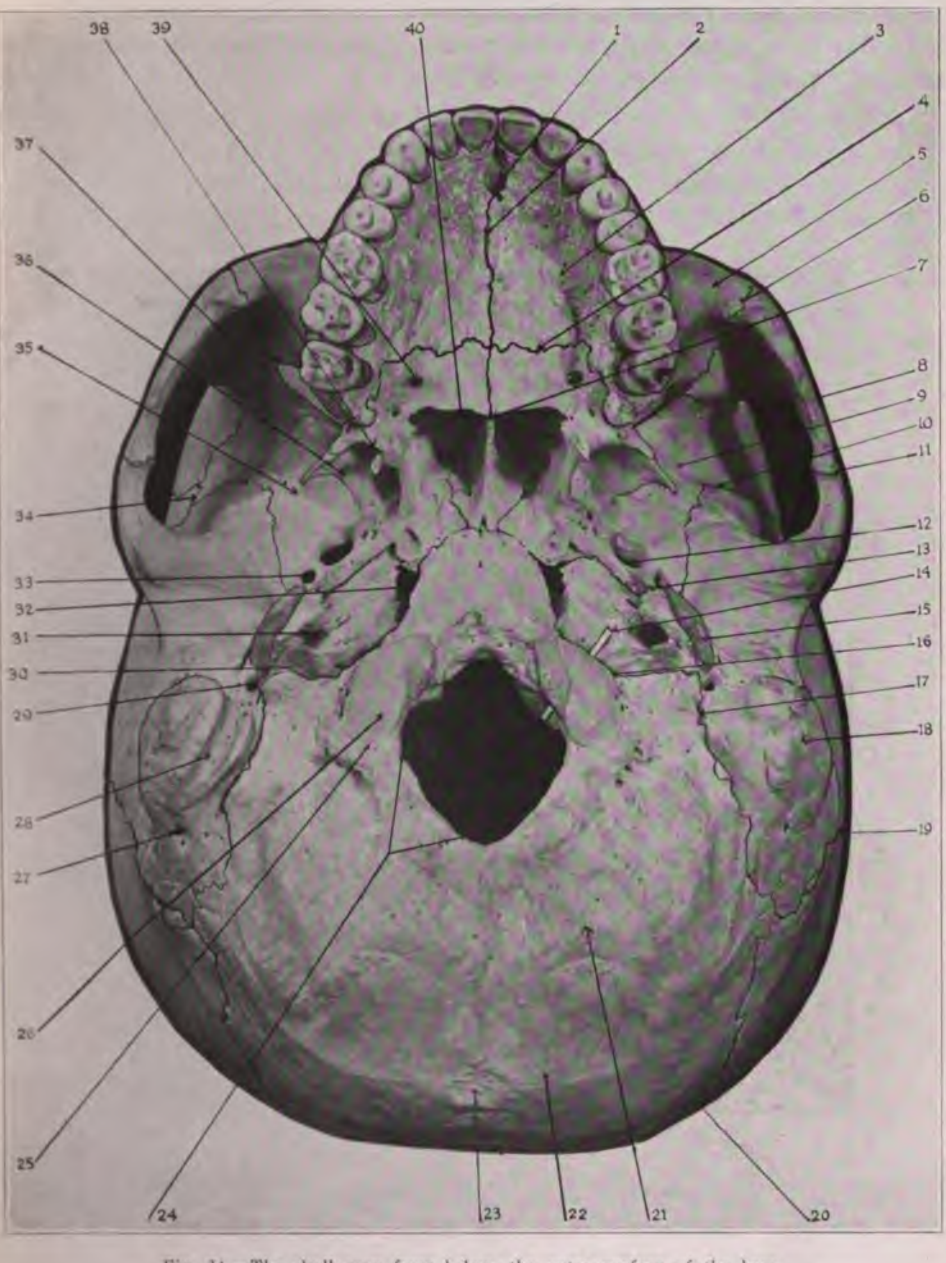


Fig. 34.—The skull seen from below, the outer surface of the base.

1, Incisive foramen; 2, median palatine suture; 3, palatine process of the superior maxilla; 4, transverse palatine suture; 5, zygomatic process of maxilla; 6, zygomatico-maxillary suture; 7, posterior nasal spine; 8, zygomatic arch; 9, infratemporal crest; 10, sphenosquamosal suture; 11, zygomaticotemporal suture; 12, foramen ovale; 13, sphenopetrosal fissure; 14, probe in hypoglossal canal; 15, petrooccipital fissure; 16, styloid process; 17, occipital mastoid suture; 18, mastoid process; 19, parietomastoid suture; 20, lambdoid suture; 21, inferior nuchal line; 22, superior nuchal line; 23, external occipital protuberance; 24, foramen magnum; 25, condyloid fossa; 26, occipital condyle; 27, mastoid foramen; 28, mastoid groove; 29, stylomastoid foramen; 30, jugular fossa; 31, orifice of carotid canal; 32, foramen lacerum; 33, foramen spinosum; 34, sphenoparietal suture; 35, infratemporal surface of the greater wing of sphenoid; 36, external pterygoid plate; 37, zygomatic bone (temporal surface); 38, internal pterygoid plate; 39, posterior palatine foramen; 40, ala vomeris.

general, it supplies the lachrymal gland, eyeball, a part of the mucous membrane lining the nasal fossa, and a portion of the skin of the forehead, eyebrow, and nose with sensation. (See Figs. 52 and 60.)

Maxillary Division.—The second, or maxillary division makes its exit from the skull by way of the foramen rotundum (see Figs. 35, 47, 55, 61 and 62), and then crosses the sphenomaxillary fossa, entering the floor of the orbit, and then assumes the name of infraorbital nerve (see Figs. 36, 39, 40, 41, 42, and 64). In general, it supplies the nose, upper lip, lower eyelids, temple, cheek, forehead and soft palate with sensation (see Fig. 60).

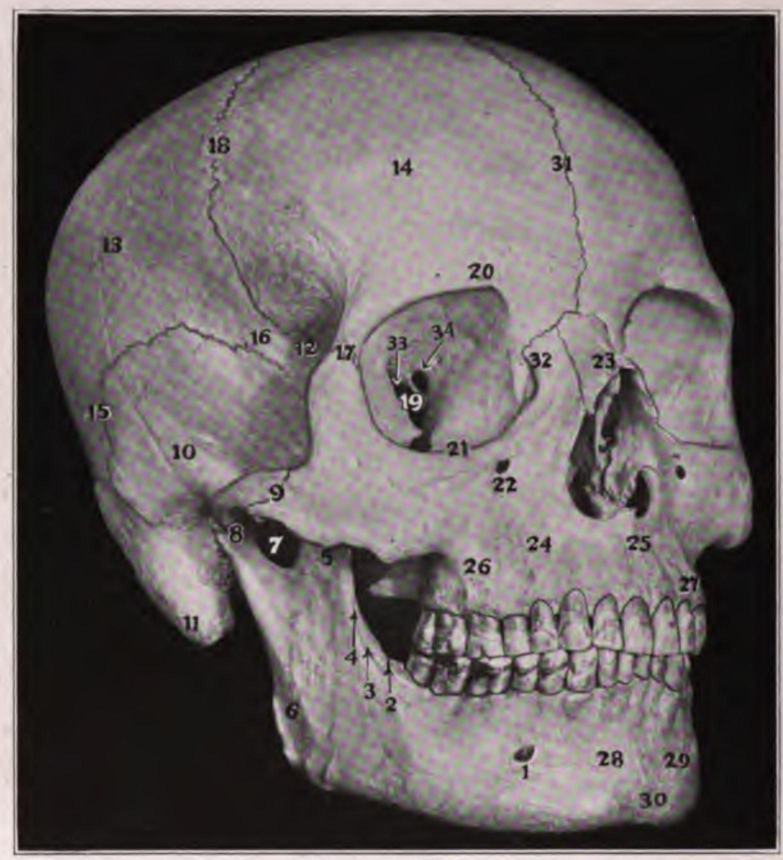


Fig. 35.

1, Mental foramen; 2, internal oblique line; 3, retromalar fossa; 4, external oblique line; 5, coronoid process; 6, angles, pterygoid tubercles; 7, sigmoid notch; 8, condyle; 9, zygomatic arch; 10, temporal bone; 11, mastoid process; 12, greater wing of sphenoid; 13, parietal bone; 14, frontal bone; 15, squamosal suture; 16, sphenoidal suture; 17, zygomaticotemporal suture; 18, coronal suture; 19, sphenomaxillary fissure; 20, supraorbital notch; 21, infraorbital margin; 22, infraorbital foramen; 23, nasal bones; 24, cuspid fossa; 25, suture of maxilla; 26, maxillary bone; 27, alveolar border; 28, and 29, incisive fossa and foramina; 30, symphysis; 31, sagittal suture; 32, frontal process.

Mandibular Division.—The third or mandibular division makes its exit from the skull through the foramen ovale (see Figs. 34, 47 and 61). It then enters the sphenomaxillary fossa, and, in general, it supplies the lower teeth, alveolar process, the major part of the lower jaw bone, mucous membrane, periosteum, the skin covering the temple, external ear, lower lip, face, and the anterior two-thirds of the tongue with sensation (see Figs. 43, 60, 84, 94, and 95). Its motor part supplies the muscles of mastication (see Figs. 40-60).

Function of the Nervus Trigeminus.—It is a mixed motor sensory nerve. Its motor fibers carry motor impulses to the muscles of mastication, anterior belly of the digastric, and mylohyoid muscles. Its sensory fibers transmit stimuli of pressure, pain, and temperatures from the nose, eye, portions of the ear, mouth, tongue, dura mater, and the anterior part of the scalp. The anterior two-thirds of the tongue is supplied by the lingual nerve, which communicates with the chorda tympani branch of the facial and hypoglossal nerves.

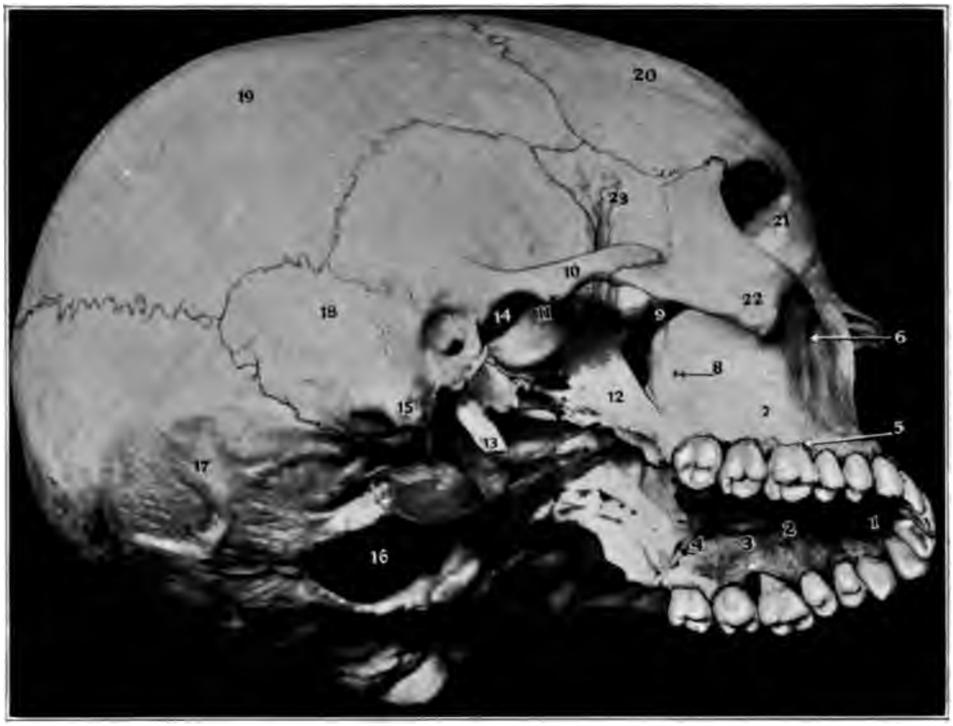


Fig. 36.

1. Incisive foramen; 2, median palatine suture; 3, palatine process of maxilla; 4, posterior palatine foramen; 5, alveolar border; 6, infraorbital foramen; 7, maxilla; 8, posterior superior alveolar foramen; 9, sphenomaxillary fissure; 10, zygomatic arch; 11, external articular tubercle; 12, pterygoid plate; 13, styloid process; 14, glenoid fossa; 15, mastoid process; 16, foramen magnum; 17, occipital bone; 18, temporal bone; 19, parietal bone; 20, frontal bone; 21, orbit; 22, zygomatic bone; 23, greater wing of sphenoid.

The Origin of the Nervus Trigeminus.—This nerve arises from two roots; a large sensory root, *portio major*, and a small motor root, *portio minor*. Motor fibers arise in part from a small nucleus located in the pons varolii and in part from a column of cells situated in the lower part of the central gray

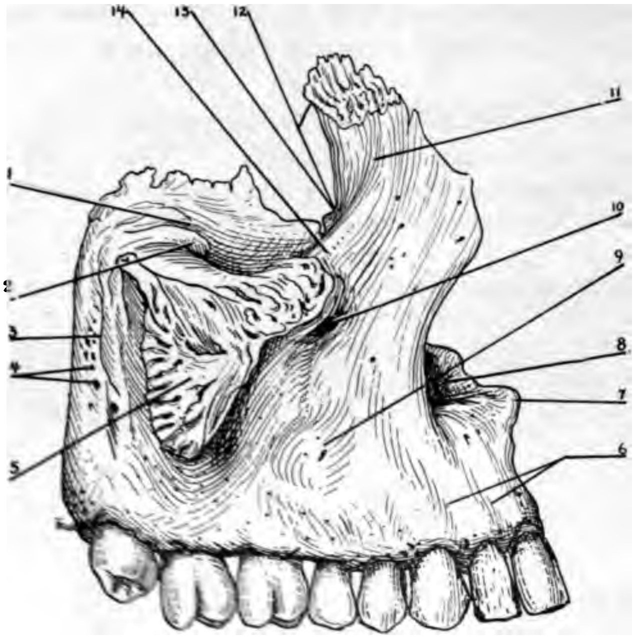


Fig. 37.

1, Orbital surface; 2, infraorbital groove; 3, infratemporal surface; 4, alveolar foramina; 5, zygomatic process; 6, juga alveolaria; 7, anterior nasal spine; 8, nasal notch; 9, canine fossa; 10, infraorbital foramen; 11, anterior lacrimal crest; 12, lacrimal border; 13, lacrimal notch; 14, infraorbital margin. (Redrawn from Sobotta McMurrich.)

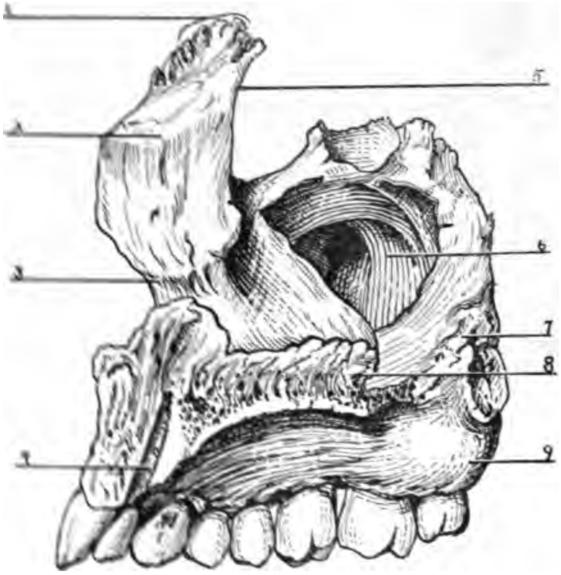


Fig. 38.

[illegible] crest; 3, conchal crest; 4, anterior palatine foramen; [illegible] pterygopalatine groove; 8, palate process; 9, tuberosity of [illegible] (Redrawn from [illegible] McMurrich.)

matter throughout the midbrain. The nerve fibers arising from these parts make up the descending motor roots of the fifth cranial nerve. (See Figs. 43, 44, 45, and 46.)

The sensory fibers of the fifth cranial nerve arise from large nerve cells located in the semilunar ganglion (Gasserian ganglion). The sensory part has two branches, one branch entering the brain and ending, in part, in a large collection of nerve cells situated in the pons varolii, in the sensory nucleus, while part of them proceeds onward, ending in a column of nerve cells which extend backward throughout the entire length of the medulla oblongata. These sensory fibers make up the descending final roots of the nervus trigeminus.

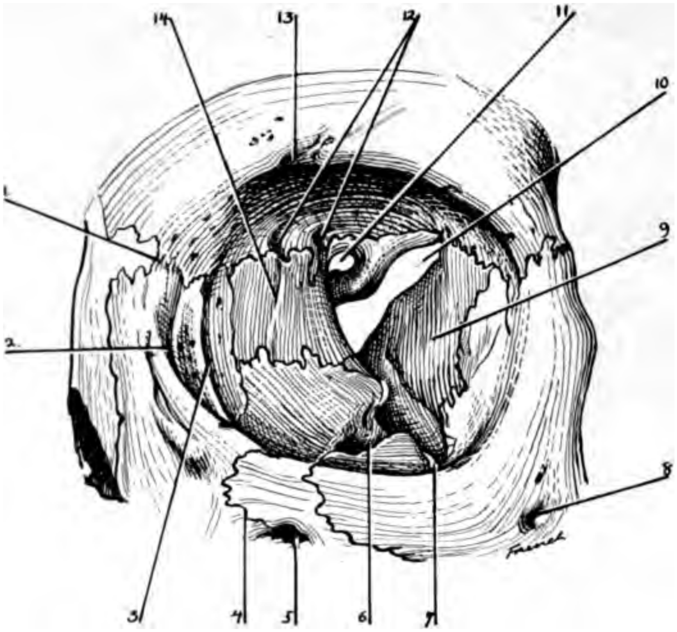


Fig. 39.

1, Frontomaxillary suture; 2, anterior lacrimal crest; 3, posterior lacrimal crest; 4, infraorbital suture; 5, infraorbital foramen; 6, infraorbital groove; 7, inferior orbital fissure; 8, zygomaticofascial foramen; 9, greater wing of sphenoid bone; 10, superior orbital fissure; 11, optic foramen; 12, ethmoidal foramina; 13, supraorbital notch; 14, lamina papyracea. (Redrawn from Sobotta-McMurrich.)

Superficial Origin of the Nervus Trigeminus.—The fifth cranial nerve emerges from the brain at a point situated upon the anterior border of the brachium base of the pons varolii or, in other words, it arises from the sides of the pons varolii. (See Fig. 46.)

Anatomy of the Nervus Trigeminus.—This nerve is the largest and most complicated of any of the twelve cranial nerves. It is formed by two roots, sensory and motor, which pass anteriorly through the posterior fossa, and these fibers pass through the dura mater at a point beneath the tentorium cerebelli, which is attached to the superior angle of the petrous portion of the temporal bone. At this point they enter the cavum Meckelii, which is situated just above the apex of the petrous portion of the temporal bone. The sensory root covers the motor root and as it courses anteriorly and enters the apex of the petrous portion of the temporal bone, it spreads out inferior to the dura mater into a large collection of nerve cells and nerve fibers which is given the name of Gasserian ganglion (semilunar ganglion).

Meckel's Cavity.—The cavum Meckelii (Meckel's cavity) is a depression which is somewhat flat and is situated external to the cavernous sinus. The floor of Meckel's cavity is made up from the trigeminal impression which is situated on the summit of the petrous portion of the temporal bone and its covering is that of the dura mater. (See Fig. 47.)

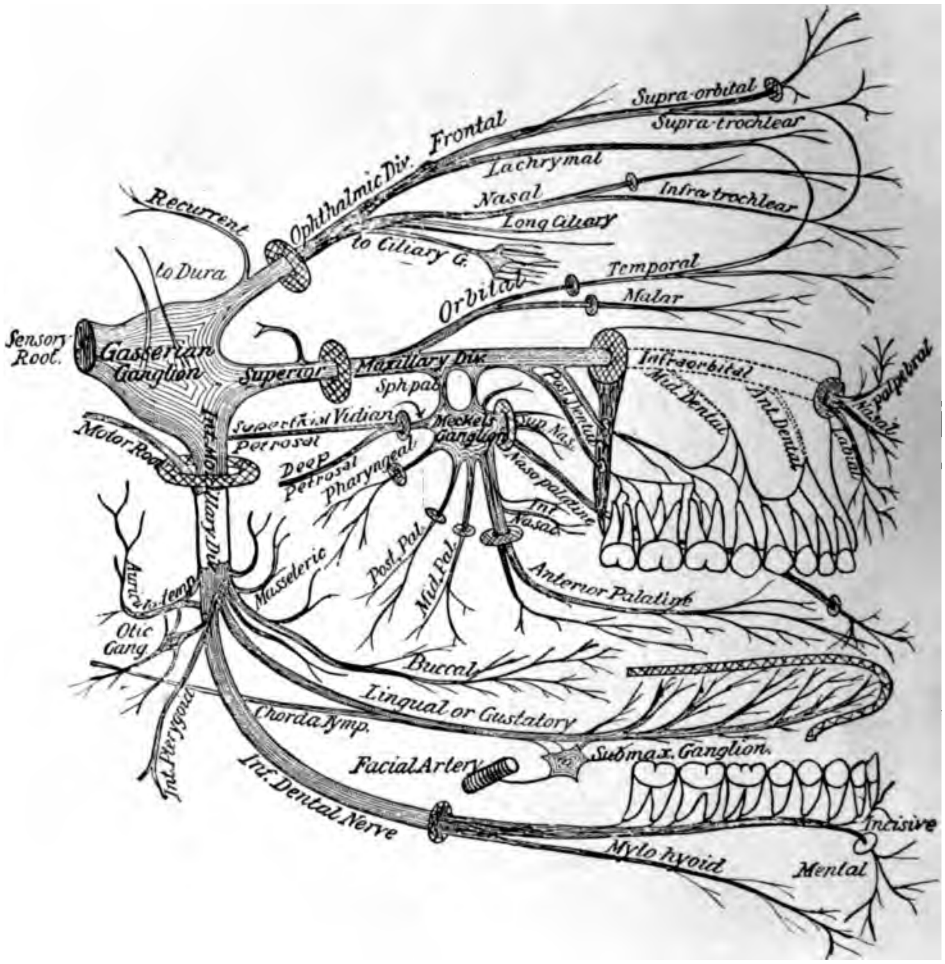


Fig. 40.—The fifth cranial nerve. (Redrawn from Potter.)

The Gasserian Ganglion (Semilunar Ganglion.)—The Gasserian ganglion is a large, irregular-shaped collection of nerve cells and fibers, situated on the anterior and superior aspects of the apex of the petrous portion of the tem-

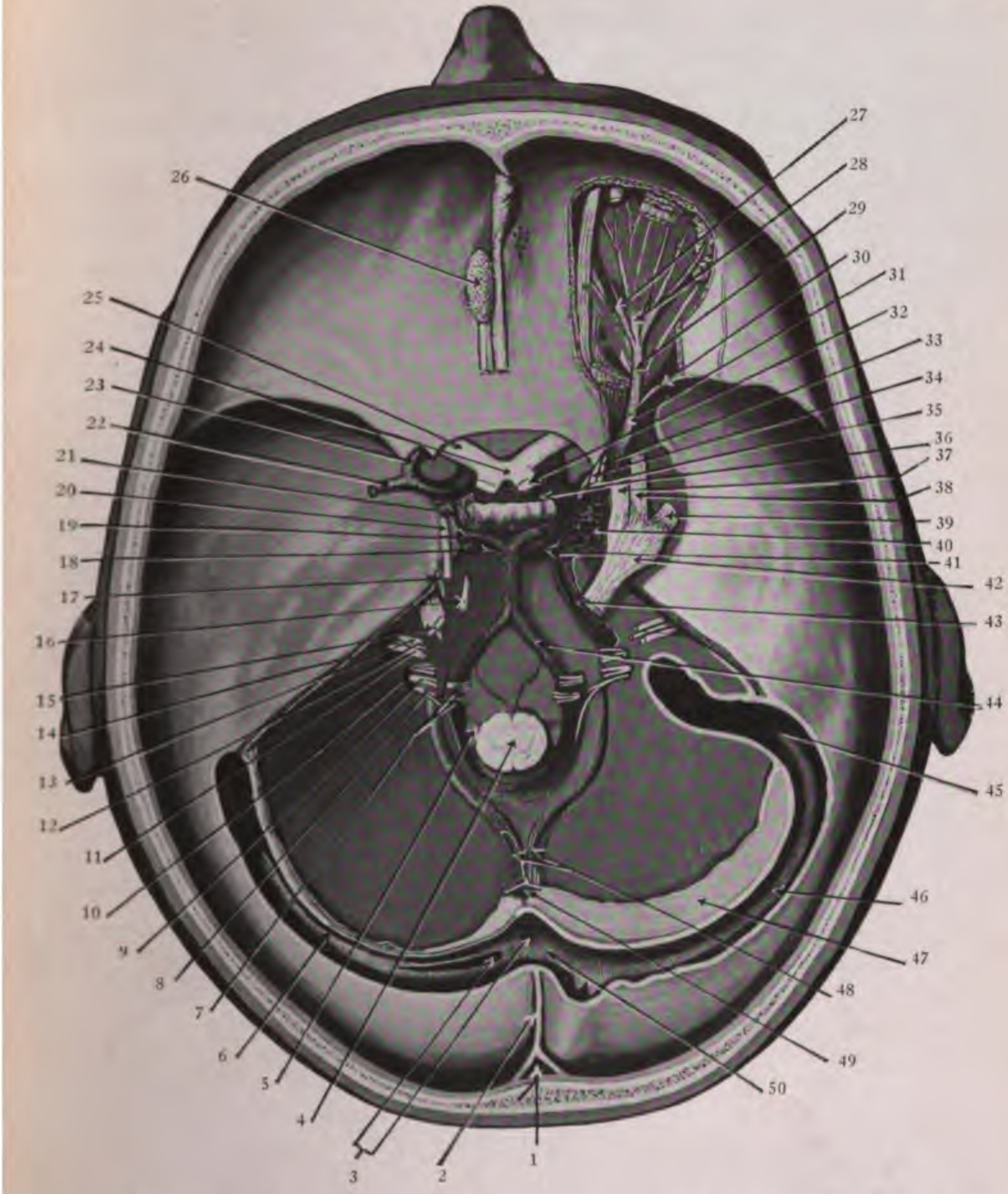


Fig. 41.—Base of the skull, to show the dura mater, sinuses, arteries and nerves. (Retouched from Cunningham.)

1, Superior sagittal sinus; 2, falx cerebri (cut); 3, openings of occipital sinus; 4, spinal medulla; 5, vertebral artery; 6, transverse sinus; 7, hypoglossal nerve; 8, accessory nerve; 9, vagus nerve; 10, glossopharyngeal nerve; 11, acoustic nerve; 12, n. intermedius; 13, facial nerve; 14, superior petrosal sinus; 15, trigeminal nerve; 16, abducens nerve; 17, trochlear nerve; 18, superior cerebellar artery; 19, posterior cerebral artery; 20, oculomotor nerve; 21, posterior communicating artery; 22, middle cerebral artery; 23, anterior cerebral artery; 24, optic chiasma; 25, optic nerve; 26, olfactory bulb; 27, infratrochlear nerve; 28, supratrochlear nerve; 29, oculomotor nerve; 30, sphenoparietal sinus; 31, ophthalmic vein; 32, anterior clinoid process; 33, trochlear nerve; 34, oculomotor nerve; 35, abducens nerve; 36, circular sinus; 37, ophthalmic nerve; 38, maxillary nerve; 39, mandibular nerve; 40, cavernous sinus; 41, basilar plexus; 42, semilunar ganglion; 43, basilar artery; 44, vertebral artery; 45, sigmoid sinus (part of transverse sinus); 46, transverse sinus: 47, tentorium cerebelli (cut); 48, occipital sinuses; 49, inferior sagittal sinus; 50, confluens sinuum.

poral bone. (See Figs. 41, 45, 48, 51, and 60.) It is situated on the sensory root at a point where the three large divisions of the fifth cranial nerve are given off and are received. This ganglion is much larger in diameter than one really expects. It is somewhat flat and triangular in shape and the average diameter is 15 mm. as demonstrated with wet specimens dissected by the author. The sensory root of the Gasserian ganglion passes backward to the brain, ending in their respective nuclei, while the motor portion passes beneath the Gasserian ganglion, and then diagonally across its inner aspect,

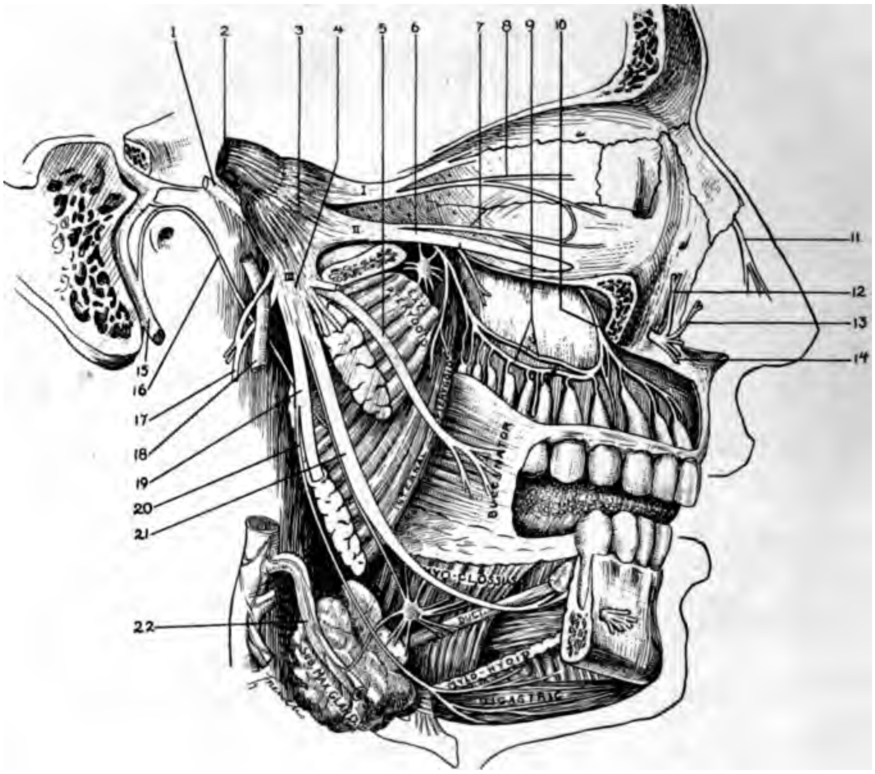


Fig. 42.

1, Motor root; 2, sensory root; 3, Gasserian ganglion; 4, inferior maxillary; 5, buccal nerve; 6, superior maxillary; 7, orbital nerve; 8, lachrymal nerve; 9, middle and posterior dental nerve; 10, anterior dental; 11, terminus of nasal nerve; 12, palpebral; 13, nasal; 14, labial; 15, facial nerve; 16, chorda tympani; 17, auriculotemporal nerve; 18, middle meningeal artery; 19, inferior dental nerve; 20, mylohyoid nerve; 21, lingual nerve; 22, facial artery. (Retouched from Gray.)

thereby uniting with the third or mandibular division. (See Figs. 40 and 60.) From the outer anterior part of this great ganglion, three large nerve trunks make their exit from the cranial cavity. (See Fig. 48.) The branch, which is located most anteriorly, is the first or ophthalmic division. The middle division is the second or maxillary division, while the lower branch is located a short distance posterior to the middle division and is the third branch, or mandibular division. The first, or ophthalmic, division and the second, or maxillary division are purely sensory, while the third, or mandibular division is a mixed nerve containing both motor and sensory fibers. The ophthalmic division is the smallest nerve trunk of the three. The mandibular division is given off from the anterior inferior part of the Gasserian ganglion, thence continues forward, making its exit through the foramen ovale. It connects with other cranial nerves which make it one of the most important sensory and motor nerves of the head. The various branches which connect this nerve with other cranial nerves will be discussed later.

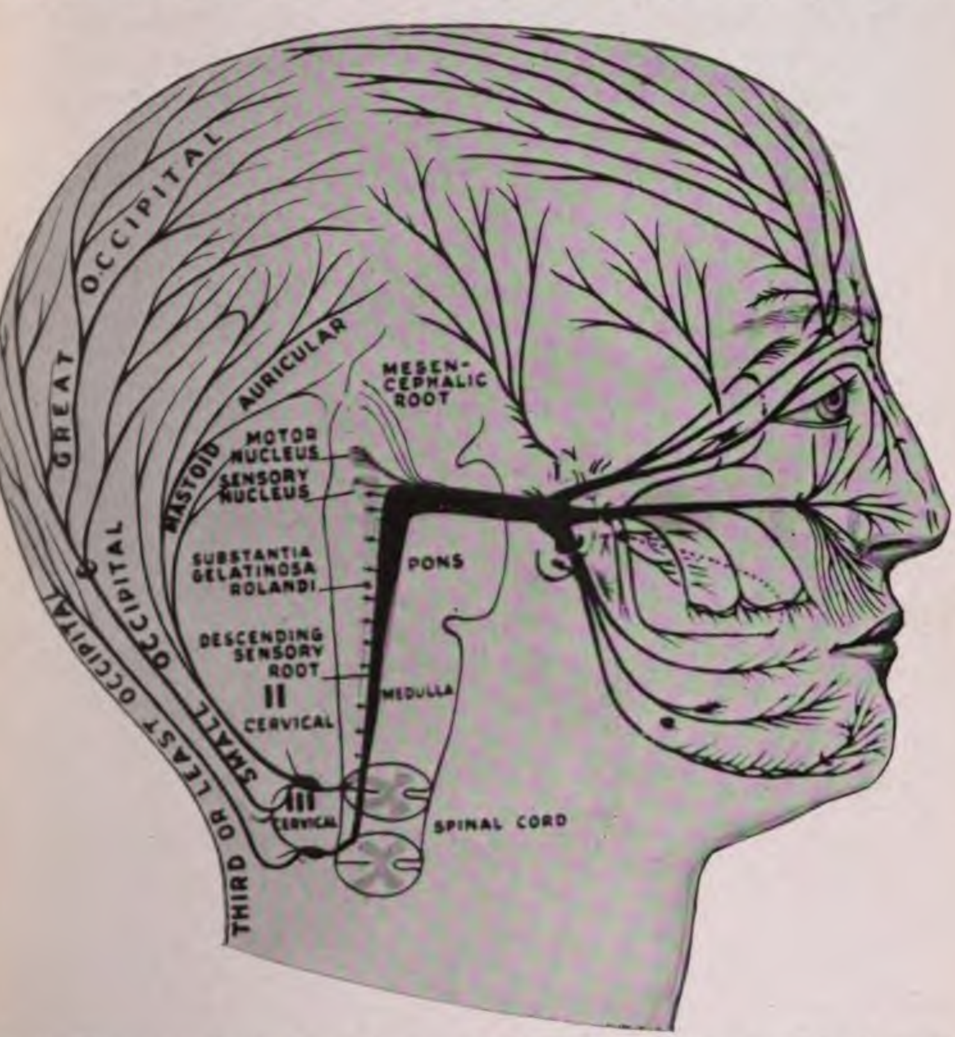


Fig. 43.—Diagrammatic drawing showing the pons, medulla, spinal cord, and the sensory distribution of the nervus trigeminus and occipital nerves. (Retouched from Pegler.)

The First, or Ophthalmic, Division.—The first, or ophthalmic division is given off the anterior superior part of the Gasserian ganglion, thence continues forward, making its exit from the cranial cavity, through the superior poral bone. (See Figs. 41, 45, 48, 51, and 60.) It is situated on the sensory root at a point where the three large divisions of the fifth cranial nerve are given off and are received. This ganglion is much larger in diameter than one really expects. It is somewhat flat and triangular in shape and the average diameter is 15 mm. as demonstrated with wet specimens dissected by the author. The sensory root of the Gasserian ganglion passes backward to the brain, ending in their respective nuclei, while the motor portion passes beneath the Gasserian ganglion, and then diagonally across its inner aspect, thereby uniting with the third or mandibular division. (See Figs. 40 and 60.) From the outer anterior part of this great ganglion, three large nerve trunks make their exit from the cranial cavity. (See Fig. 48.) The branch, which is located most anteriorly, is the first or ophthalmic division. The middle division is the second or maxillary division, while the lower branch is located a short distance posterior to the middle division and is the third branch, or mandibular division. The first, or ophthalmic, division and the second, or

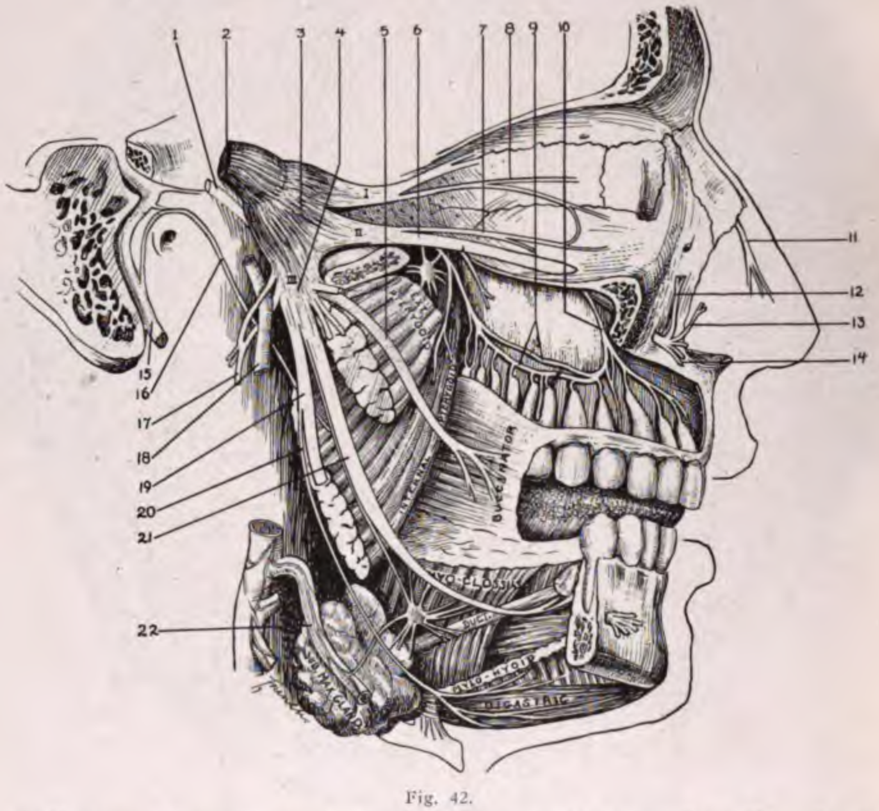


Fig. 42.

1, Motor root; 2, sensory root; 3, Gasserian ganglion; 4, inferior maxillary; 5, buccal nerve; 6, superior maxillary; 7, orbital nerve; 8, lachrymal nerve; 9, middle and posterior dental nerve; 10, anterior dental; 11, terminus of nasal nerve; 12, palpebral; 13, nasal; 14, labial; 15, facial nerve; 16, chorda tympani; 17, auriculotemporal nerve; 18, middle meningeal artery; 19, inferior dental nerve; 20, mylohyoid nerve; 21, lingual nerve; 22, facial artery. (Retouched from Gray.)

maxillary division are purely sensory, while the third, or mandibular division is a mixed nerve containing both motor and sensory fibers. The ophthalmic division is the smallest nerve trunk of the three. The mandibular division is given off from the anterior inferior part of the Gasserian ganglion, thence continues forward, making its exit through the foramen ovale. It connects with other cranial nerves which make it one of the most important sensory and motor nerves of the head. The various branches which connect this nerve with other cranial nerves will be discussed later.

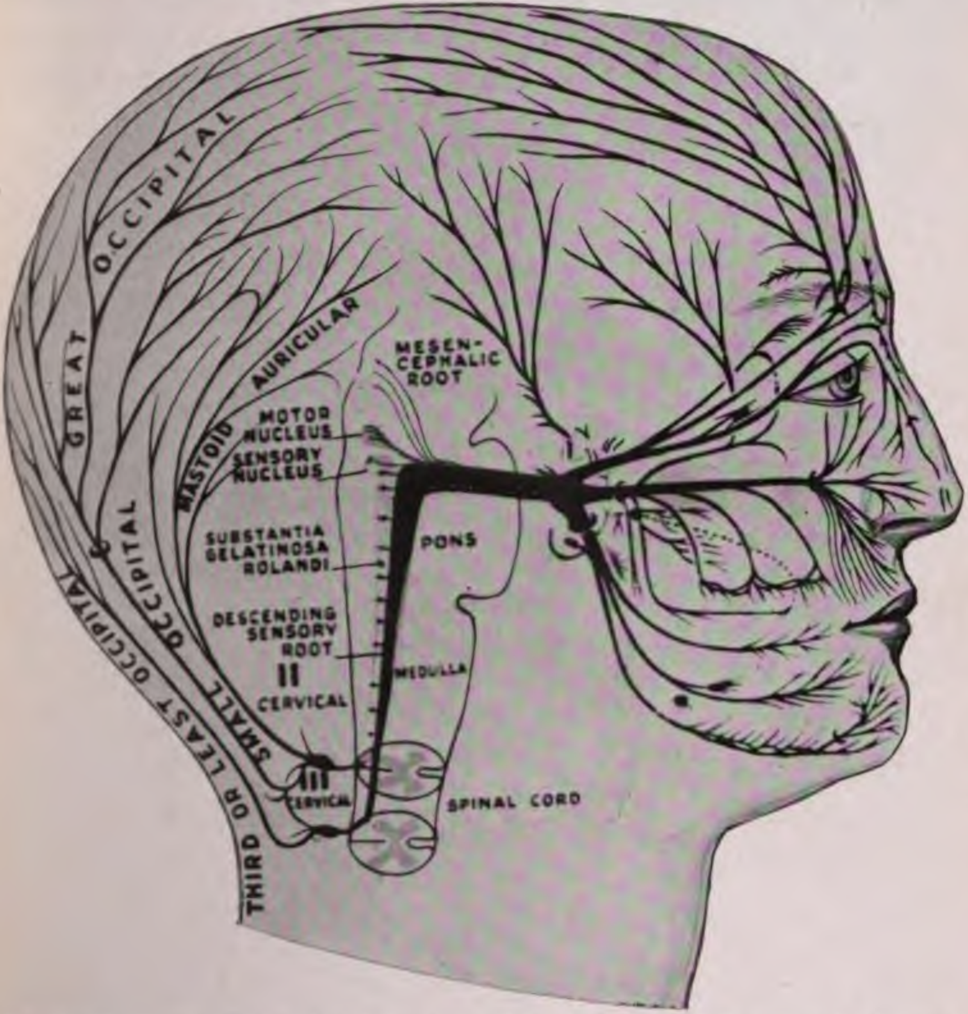


Fig. 43.—Diagrammatic drawing showing the pons, medulla, spinal cord, and the sensory distribution of the nervus trigeminus and occipital nerves. (Retouched from Pegler.)

The First, or Ophthalmic, Division.—The first, or ophthalmic division is given off the anterior superior part of the Gasserian ganglion, thence continues forward, making its exit from the cranial cavity, through the superior

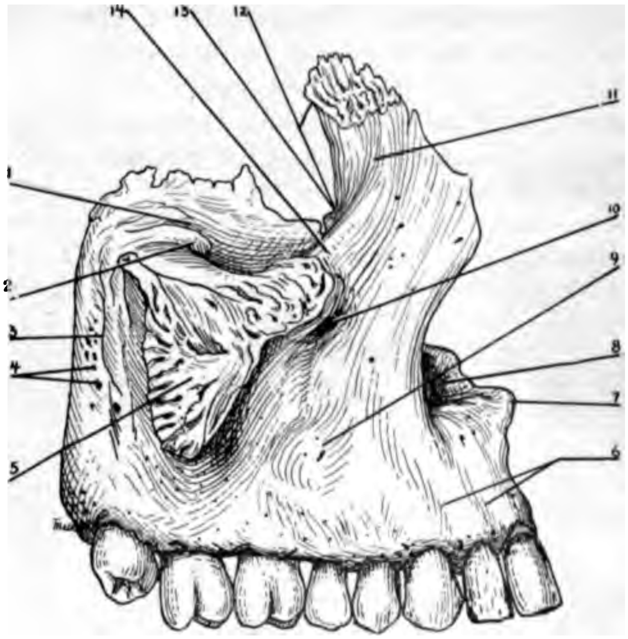


Fig. 37.

1, Orbital surface; 2, Infraorbital groove; 3, infratemporal surface; 4, alveolar foramina; 5, zygomatic process; 6, juga alveolaria; 7, anterior nasal spine; 8, nasal notch; 9, canine fossa; 10, infraorbital foramen; 11, anterior lacrimal crest; 12, lacrimal border; 13, lacrimal notch; 14, infraorbital margin. (Redrawn from Sobotta McMurrich.)

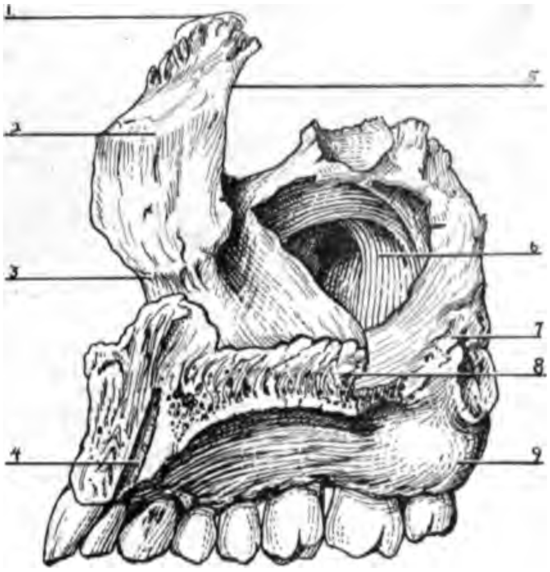


Fig. 38.

1, Frontomaxillary suture; 2, ethmoidal crest; 3, conchal crest; 4, anterior palatine foramen; 5, frontal process; 6, maxillary sinus; 7, pterygopalatine groove; 8, palate process; 9, tuberosity of maxilla. (Redrawn from Sobotta-McMurrich.)

ing branches to the auriculotemporal, which is a branch of the third or mandibular division; with the frontal ramus, and with the cervical plexus by way of the greater occipital nerve.

The following diagram shows the various branches which are given off from the supraorbital nerve:

SUPRAORBITAL NERVE	Branch to frontal sinus which supplies the mucous membrane. Palpebral branch to the skin of the upper eyelid. Small branches to diploe. Branches to skin of forehead, scalp, and vertex. Communicating branch with facial nerve.

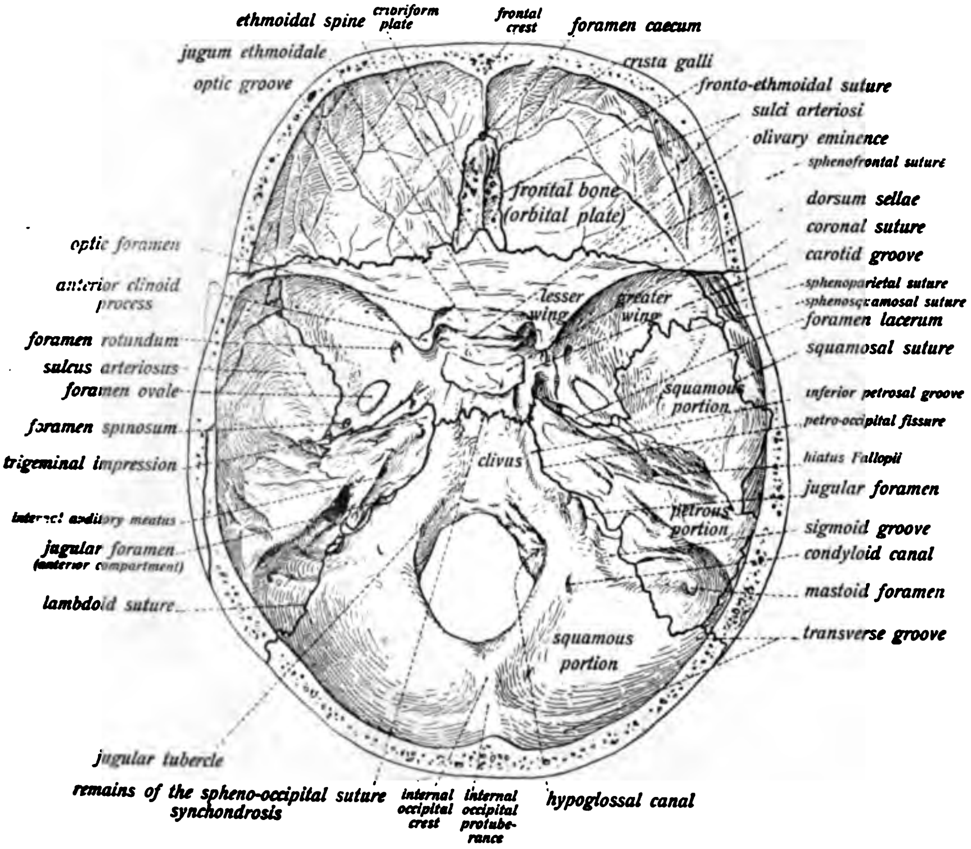


Fig. 47.—The inner surface of the base of the skull. (From Sobotta-McMurrich.)

Frontal Ramus.—This is the middle branch of the frontal nerve and maintains the same name. It passes anteriorly and is located near the supraorbital nerve, passes out of the orbital cavity through the supraorbital notch or foramen and then passes upward in the skin of the forehead located medially to the other branches, supplying the skin in this region and anastomoses with the supraorbital and supratrochlear nerves. (See Fig. 51.)

Supratrochlear Nerve.—This is the smallest of the three branches which is given off the frontal nerve, and it passes obliquely anteriorly in the roof of the orbit towards the tendon of the superior oblique muscle, thence anteriorly and medially, passing out of the orbital cavity over the medial portion of the supraorbital arch. Its branches pass superiorly and medially, supplying the skin of the forehead, the root of the nose and the inner aspect of the upper

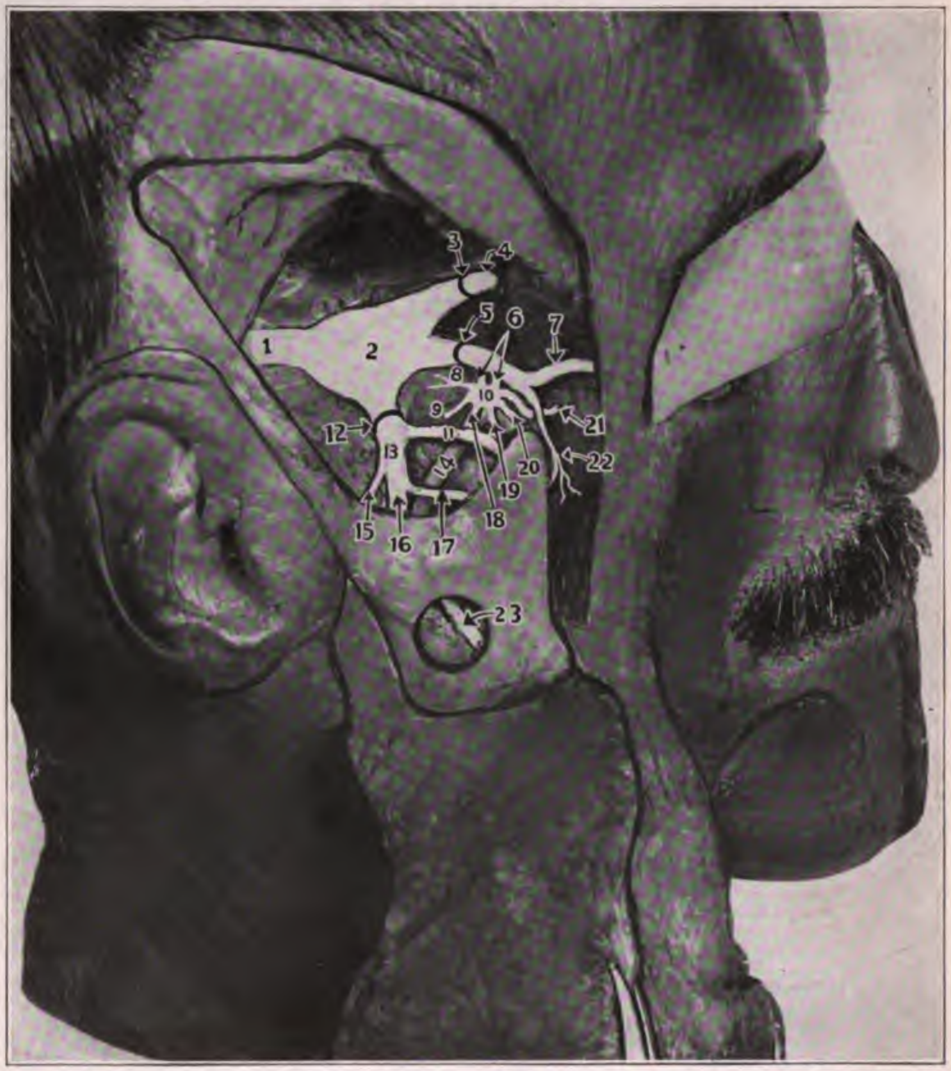


Fig. 48.—Wet anatomical specimen which has been carefully dissected and shows the following structures:

1, Sensory root of trigeminal nerve; 2, semilunar (Gasserian) ganglion; 3, superior orbital (sphenoidal) fissure; 4, ophthalmic division of trigeminal nerve; 5, foramen rotundum; 6, sphenopalatine nerves; 7, infraorbital nerve; 8, vidian nerve; 9, posterior palatine nerve; 10, sphenopalatine (Meckel's) ganglion; 11, buccinator nerve; 12, foramen ovale; 13, mandibular nerve; 14, internal maxillary artery; 15, auriculotemporal nerve; 16, inferior dental nerve; 17, lingual nerve; 18, middle palatine nerve; 19, anterior palatine nerve; 20, nasopalatine nerve; 21, posterior lateral nasal nerve; 22, posterior superior dental nerve; 23, inferior dental nerve.

eyelid. This nerve anastomoses with the trochlear branch of the nasociliary nerve. (See Figs. 54-*A*, 56, and 60.)

The Lachrymal Nerve.—The lachrymal nerve is a branch of the first or ophthalmic division. It passes anteriorly just beneath the roof of the orbital cavity in a space which is situated between the lateral and superior recti muscles until it reaches the anterior part of the orbit. It gives off branches which supply the lachrymal gland, the conjunctiva and the skin, composing the lateral commissure of the eye. It also gives off a small branch which communicates with the zygomatic nerve, which is a branch of the second or maxillary di-

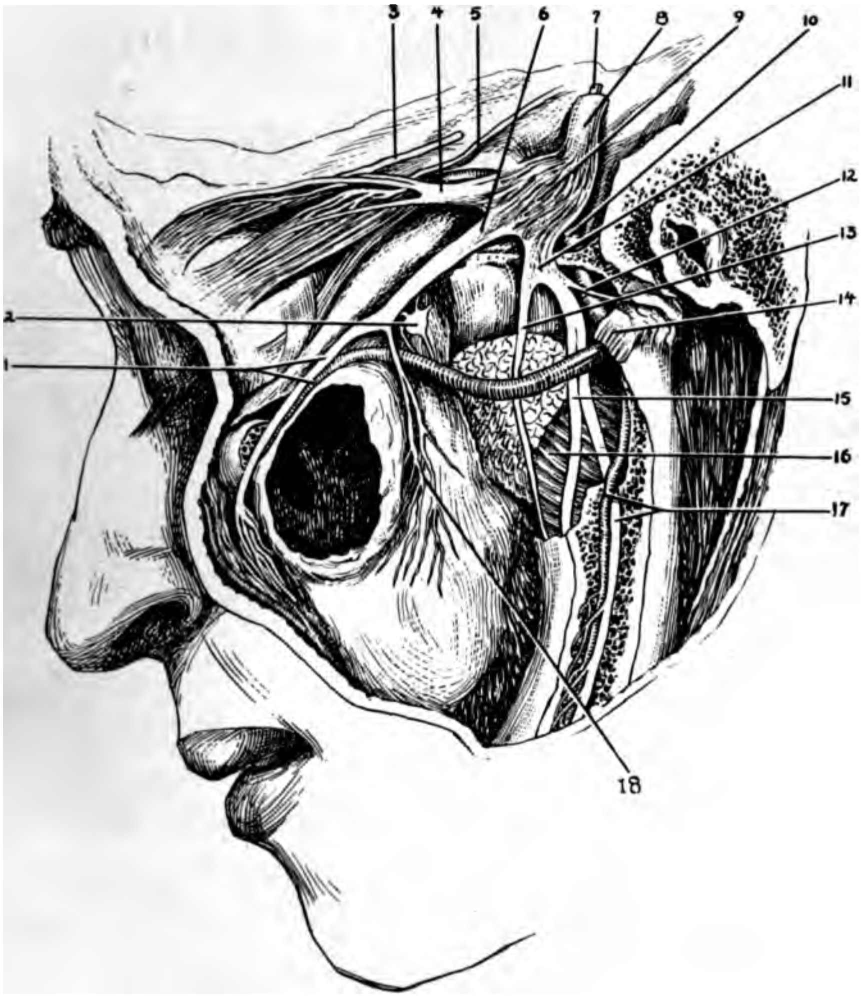


Fig. 49.

1, Infraorbital nerve and artery; 2, Meckel's ganglion; 3, third nerve; 4, ophthalmic branch of fifth nerve; 5, fourth nerve; 6, maxillary branch; 7, motor root; 8, sensory root; 9, Gasserian ganglion; 10, middle meningeal artery; 11, mandibular branch; 12, temporomalar nerve; 13, buccal branch; 14, stump external pterygoid muscle; 15, lingual nerve; 16, internal pterygoid muscle; 17, inferior alveolar nerve and artery; 18, posterior superior dental nerve. (Modified from Davis.)

vision of the fifth nerve. The various branches of the lachrymal nerve are contained in the following diagram:

LACHRYMAL BRANCH
- Anastomosing branch with zygomatic nerve of second or maxillary division.
- Branch to lachrymal gland.
- Conjunctiva.
- Skin of outer canthus.

Nasociliary, or Nasal, Branch.—This nerve is given off the first, or ophthalmic division and passes anteriorly from the superior orbital fissure and enters the orbital cavity, proceeding anteriorly in an oblique manner between the medial rectus and the superior oblique muscle. (See Figs. 51, 54-*A* and 54-*B*.) It divides near the anterior ethmoidal foramen, and forms a number of branches which are given below. The terminal branch of this nerve passes through the anterior ethmoidal foramen and is called the anterior ethmoidal, and after passing through the foramen enters the substance of the ethmoidal bone, thence through the nasal fissure, entering the nasal cavity which supplies the mucous membrane located in the anterior superior part of the nasal septum. The anterior ethmoidal nerve is divided into two branches which are called the medial and lateral. (See Figs. 79, 91, 92, and 98.) The medial branch supplies sensation to the mucous membrane covering the upper and anterior part of

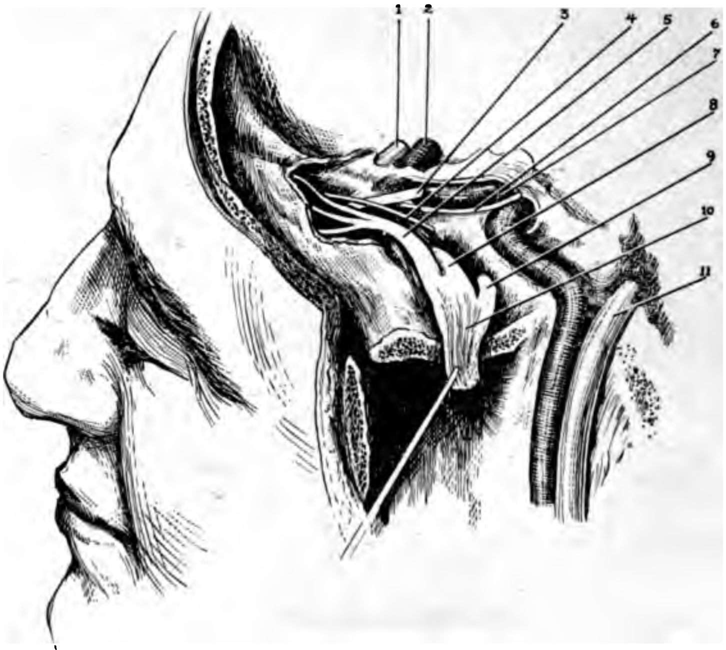


Fig. 50.

1, Optic nerve; 2, ophthalmic artery; 3, third nerve; 4, fourth nerve; 5, ophthalmic branch of the fifth nerve; 6, sixth nerve; 7, internal carotid artery; 8, maxillary branch of the fifth nerve; 9, mandibular branch of the fifth nerve; 10, Gasserian ganglion turned forward; 11, internal jugular vein. (Redrawn from Davis.)

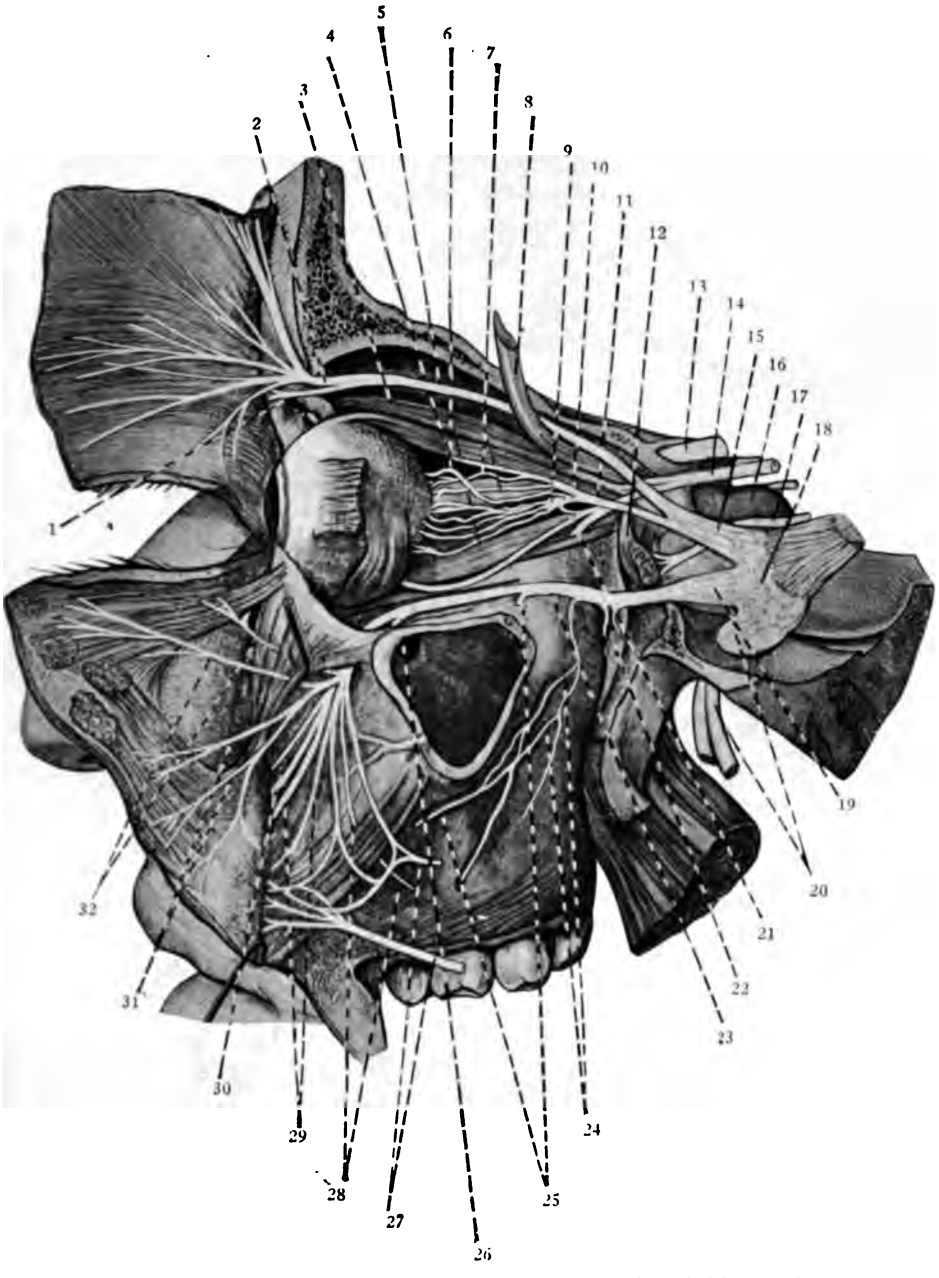


Fig 51 Specimen showing the Gasserian ganglion, its three principal divisions and branches. (Retouched from Toldt.)

1, Ramus frontalis; 2, n.supraorbitalis; 3, m. obliquus superior; 4, m. rectus superior; 5, n. frontalis; 6, nn. ciliares breves; 7, nn. ciliares longi; 8, m. levator palpebrae superioris; 9, ganglion ciliare; 10, radix longa ganglii ciliaris; 11, n. nasociliaris; 12, m. rectus lateralis; 13, n. opticus; 14, n. oculomotorius; 15, n. ophthalmicus; 16, a. carotis interna; 17, n. abducens; 18, ganglion semilunare; 19, n. maxillaris; 20, n. mandibularis; 21, radix brevis ganglii ciliaris; 22, ganglion sphenopalatinum; 23, n. infraorbitalis; 24, rami alveolares superiores posteriores; 25, ramus alveolares superiores medius; 26, ramus alveolaris superior anterior; 27, branch of n. facialis; 28, branch of mucous membrane of cheek; 29, rami labiales superiores; 30, ramus nasalis externus; 31, branch of skin of cheek; 32, rami palpebrales inferiores.

the nasal septum, while the lateral branch supplies the mucous membrane cove ing the upper lateral wall of the nasal cavity, later appearing upon the fa under the name of the external nasal nerve which supplies the skin of the ti of the nose with sensation. (See Figs. 56 and 59.)

The nasociliary nerve gives off five principal branches which are desi nated in the accompanying diagram as well as subdivisions and structur supplied:

- NASOCILIARY, OR NASAL NERVE.
  - Long root which is the sensory root of ciliary ganglion.
  - INFRATROCHLEAR
    - SUPERIOR PALPEBRAL RAMUS
      - Anastomosing branch to supratrochlear nerve.
      - Branch to lachrymal sac.
      - Branch to inner canthus of eye.
      - Branch to medial ⅓ to ½ of superior eyelid and conjunctiva.
    - INFERIOR PALPEBRAL RAMUS
      - Anastomosing branch to infraorbital nerve.
      - Cutaneous branches to skin of root and upper part of nose.
  - Long ciliary branches to eyeball, iris, cornea and ciliary body.
  - Posterior ethmoidal to mucous membrane of sphenoidal sinus and posterior ethmoidal cells.
  - Anterior ethmoidal branch to frontal sinus and anterior ethmoidal cells.
  - INTRANASAL SECTION
    - INTERNAL BRANCHES
      - Branches to anterior part of nasal septum and continue as cutaneous branches which supply the anterior inferior part of nose.
    - EXTERNAL BRANCHES
      - Branch to anterior lateral part of wall of nasal fossa.
      - Branch to anterior half of inferior meatus and turbinate bone.
      - Branch to anterior half of middle meatus and turbinate bone.

The Ciliary Ganglion

Synonyms.—*Ophthalmic*, or *lenticular ganglion.*

This ganglion is approxiately 2 mm. in diameter, and is situated near th optic nerve internal to the abducent nerve, and is surrounded by fatty tissu (see Figs. 52 and 60). This ganglion has three roots—a motor branch derive from the motoroculi or third cranial nerve, a sensory branch which is give off the nasal branch of the first or ophthalmic, and a sympathetic root or branc which is derived from the cavernous plexus. The motor fibers supply the ir trinsic muscles of the eyeball with motor impulses. This ganglion gives o from ten to fifteen short branches, which are called the short ciliary nerves an are divided into an upper and lower group, they being separated by the optic nerve. These branches pass anteriorly along the optic nerve to the posterior border of the eyeball, at which point they pierce the sclera and supply the several coats lining the eyeball, as well as the ciliary muscles and eyelids. These are mixed nerves, being sympathetic, sensory, and motor. The following diagram gives the origin and branches of the ciliary ganglion:

CILIARY GANGLION Origin by three roots which are:	1. Motor branch from the third or oculomotor. 2. Sensory branch from the nasociliary (nasal) nerve of the ophthalmic division. 3. Sympathetic branches from the carotid plexus.	Gives off ten to fifteen branches to	All coats of eyeball. Ciliary muscle. Iris. Cornea.

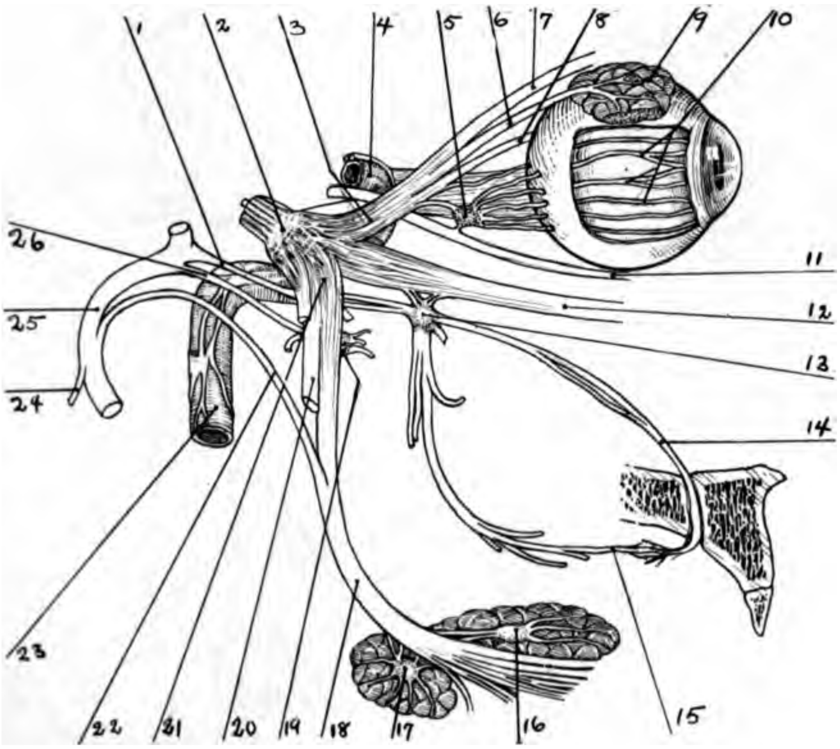


Fig. 52.—Scheme of the Fifth Cranial Nerve and Its Ganglia. (Redrawn from Buchanan.)

1. Great superficial petrosal nerve; 2, Gasserian ganglion: 3, ophthalmic or first division; 4, internal carotid artery; 5, ciliary ganglion; 6, lacrimal nerve; 7, frontal nerve; 8, nasal nerve; 9, lacrimal gland; 10, ciliary nerve; 11, branch of third cranial nerve to inferior oblique muscle; 12, superior maxillary or second division; 13, sphenomaxillary or Meckel's ganglion; 14, nasopalatine nerve which forms the anterior portion of the inner nerve loop; 15, anterior palatine nerve which forms the posterior portion of inner nerve loop; 16, sublingual ganglion; 17, submaxillary ganglion; 18, lingual nerve; 19, otic or Arnold's ganglion; 20, inferior dental nerve; 21, mandibular or third division; 22, corda tympani nerve; 23, internal carotid artery; 24, posterior auricular nerve; 25, facial nerve in aqueduct of Fallopius; 26, branch to small superficial petrosal nerve.

Nervus Maxillaris, or Second Division

The maxillary, or second, division of the fifth cranial nerve is given c from the external anterior border of the Gasserian ganglion. (See Figs. 4 51, and 52.) This division is slightly larger than the first or ophthalmic divisio is flattened or oval in shape, and is at least 4 mm. in diameter as it mak its exit from the cranial cavity through the sphenoid bone. This nerve is pure sensory and supplies the greater part of the superior maxillary bone, antrui teeth, periosteum, alveolar process, mucous membrane, upper part of cheek, so and hard palates, tonsils, posterior and anterior pillars, uvula, etc., wi

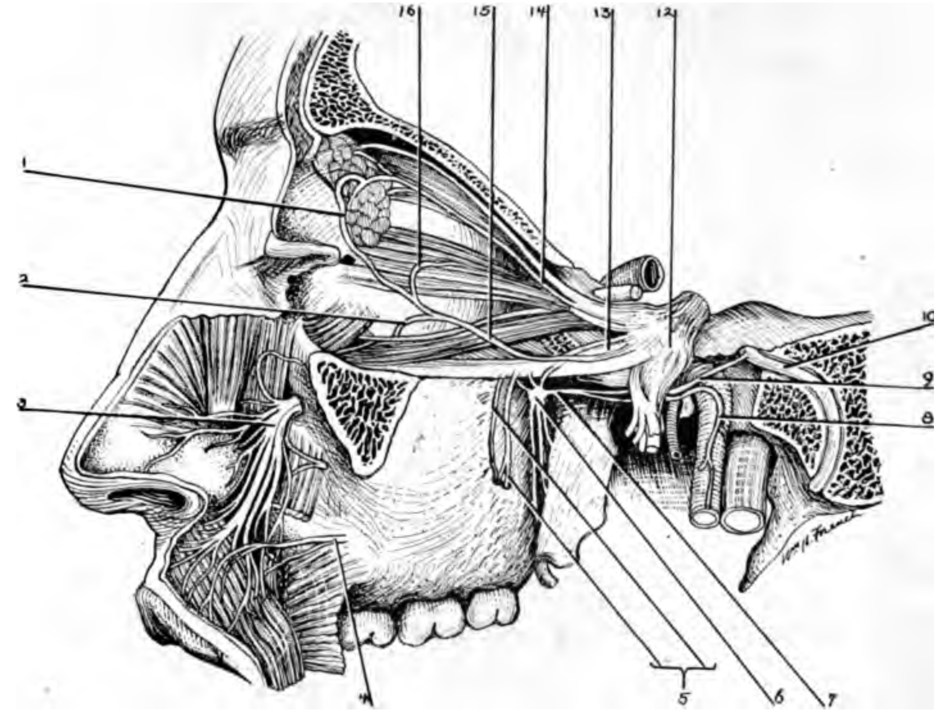


Fig. 53.—Distribution of superior maxillary nerve. (Redrawn from Hirschfeld and Leveille.)

1, Anastomosis with orbital nerve; 2, zygomatico-facial or malar branch; 3, anterior termir branches of the infraorbital nerve; 4, buccal branch of facial nerve; 5, posterior superior dental branche 6, Meckel's ganglion; 7, Vidian nerve; 8, deep petrosal nerve; 9, great superficial petrosal; 10, tac nerve; 12, Gasserian ganglion; 13, superior maxillary nerve; 14, lacrimal nerve; 15, orbito or tempoı malar branch; 16, zygomatico-temporal branch.

sensation. This large nerve trunk passes anteriorly from the Gasserian gaı glion beneath the dura mater in the middle fossa of the skull, and pass out of the cranial cavity by way of the foramen rotundum, which is locate in the greater wing of the sphenoid bone (see Figs. 41, 42, 43, 47, 54-*A*, and 60 After emerging from the foramen rotundum, it crosses the pterygopalatiı (sphenomaxillary) fossa, and enters the posterior part of the floor of the orb (see Figs. 60, 64, and 68). The pterygopalatine fossa is approximately 1 mm. in width where the second division crosses it (see Figs. 48 and 64). B

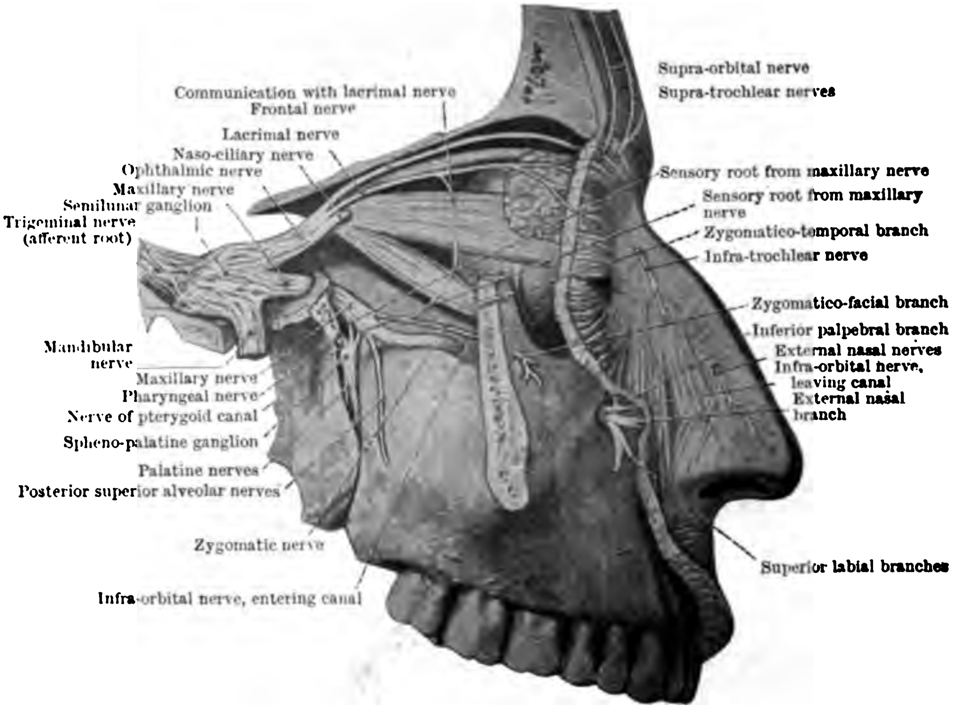


Fig. 54-*A*.—The course of the ophthalmic and maxillary nerves. (From Cunningham.)

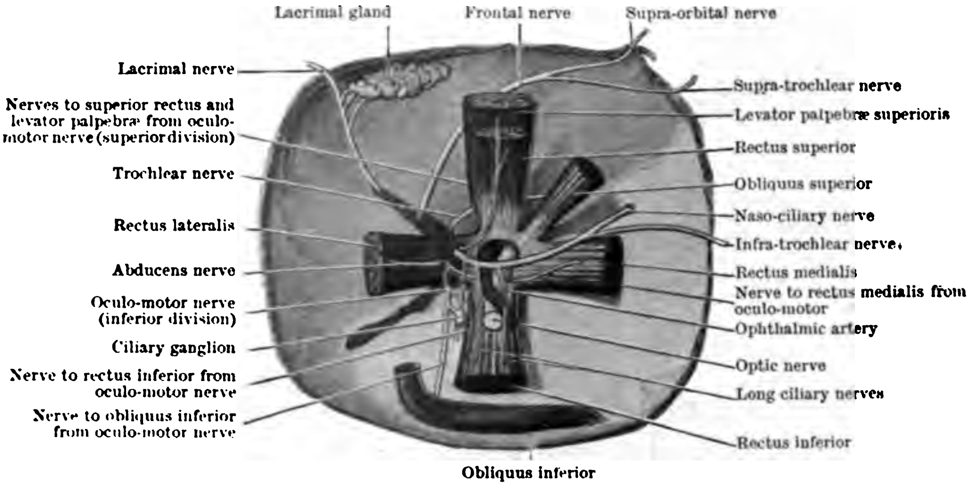


Fig. 54-*B*.—Schematic representation of the nerves which traverse the cavity of the orbit. (From Cunningham.)

fore the second division makes its exit, through the **foramen rotundum,** while yet in the cavity of the cranium it gives off the middle meningeal (recurrent nerve), which supplies the dura mater located in the region of the middle fossa of the skull (see Fig. 40). After this large nerve makes its exit from the cranial cavity through the foramen rotundum, it divides into two main branches, or divisions. One main branch continues in the floor of the orbit (see Figs. 68 and 70), and assumes the name of infraorbital nerve, which takes an almost straight course anteriorly, making its exit upon the face through the infraorbital foramen (see Figs. 70 and 75). The other main branch or division forms the sphenopalatine nerve, which passes to the sphenopalatine ganglion (Meckel's ganglion), which is its chief sensory root, and branches to the palate and nasal cavity (see Figs. 40, 53, 54-*A*, and 60). For convenience, it is well to divide the branches given off of this great nerve trunk in accordance with the various locations. The branches of this nerve will therefore be discussed under the four following groups:

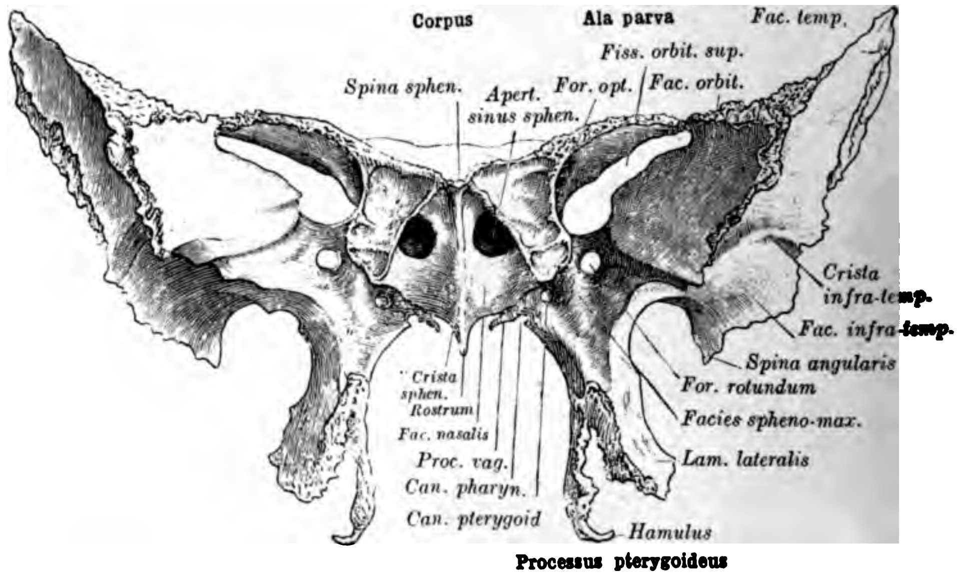


Fig. 55.—Sphenoid bone, anterior view. (From Quain.)

1. Branches given off the second division within the cranium.
2. Branches given off the second division within the pterygopalatine fossa.
3. Branches given off the infraorbital nerve within the infraorbital canal.
4. Branches given off the infraorbital nerve upon the face.

BRANCHES GIVEN OFF WITHIN THE CAVITY OF THE CRANIUM	Middle meningeal (recurrent nerve) which supplies the dura mater in middle fossa and to plexus located on middle meningeal

The branches which are given off within the pterygopalatine fossa (sphenomaxillary fossa) numbering five, and sometimes six, are given in the outline on page 95.

Sphenopalatine Nerves

The first two branches given off within the pterygopalatine fossa are two short nerves called sphenopalatine, which course downward and slightly laterally, connecting with the sphenopalatine ganglion (Meckel's ganglion) and makes up the sensory part of this ganglion. The average length of the sphenopalatine nerve is approximately 5 mm., and acts as a sensory connecting link between Meckel's ganglion and the second division. (See Figs. 48, 60, 78.)

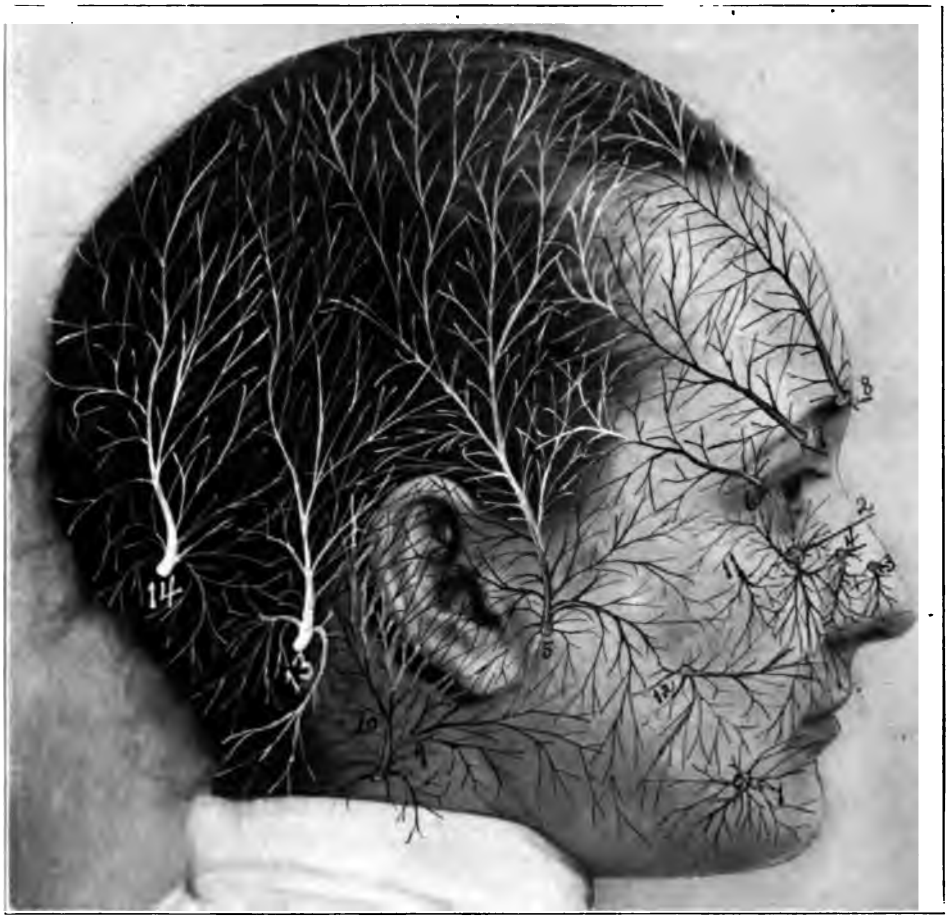


Fig. 56.—Illustrating the sensory nerve supply of the face, forehead, and scalp.

1, Mental nerve; 2, infraorbital nerve; 3, and 4, external nasal branches; 5, auriculotemporal nerve from third division; 6, zygomaticotemporal nerve from second division; 7, supraorbital nerve from first division; 8, supratrochlear nerve from first division; 9-10, greater auricular nerve; 11, malar nerve; 12, long buccal nerve; 13, lesser occipital nerve; 14, greater occipital nerve.

Posterior Superior Dental (Alveolar) Nerve

The next branch given off is called the posterior superior alveolar nerve (rami alveolares superiores posteriores). (See Figs. 60, 64, 65 and 66.) These nerves may be two or more in number. In two instances the author has found two posterior superior alveolar nerves, instead of one, and in both cases the branches were given off, from the second division, very close to each other. In two other specimens, which have been dissected, the posterior superior dental nerve was given off as one branch, and after extending downward and laterally to a distance approximately one-half inch, divided into two

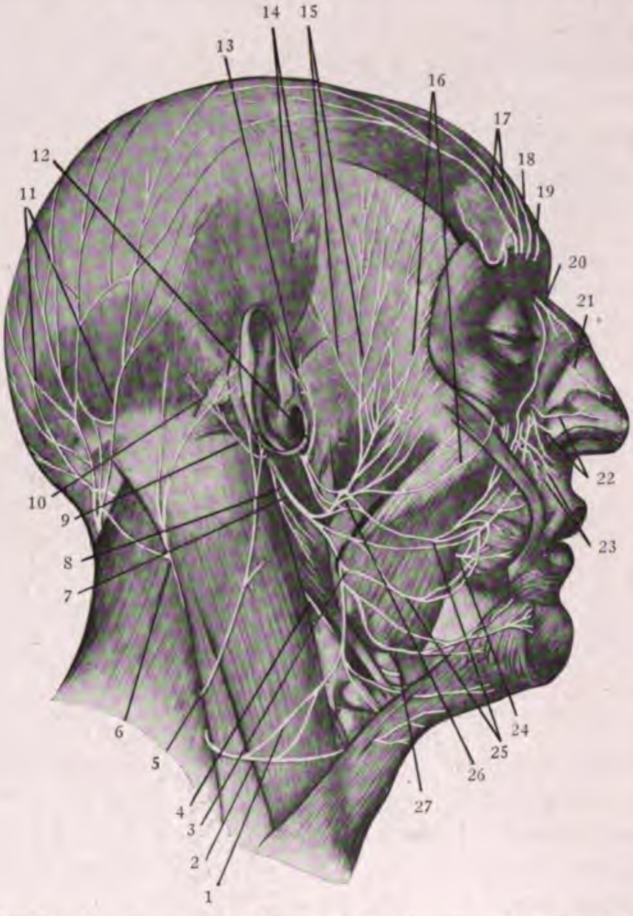


Fig. 57.—Peripheral nerves of the face and head. (Retouched from Toldt.)

1, Ansa cervicalis superficialis; 2, superficial cervical nerve; 3, cervical or inframaxillary branch; 4, hypoglossal nerve; 5, great auricular nerve; 6, small occipital nerve; 7, facial nerve; 8, digastric branch; 9, posterior auricular nerve; 10, occipital branch; 11, branches of great occipital nerve; 12, superficial temporal nerve; 13, anterior auricular nerves; 14, superficial temporal branches of auriculotemporal nerve; 15, temporal branches of facial nerve; 16, malar branches of facial nerve; 17, supraorbital nerve; 18, inner branch; 19, supratrochlear nerve; 20, infratrochlear nerve; 21, anterior or superficial branch of nasal nerve; 22, lateral nasal branches of infraorbital nerve; 23, superior labial branches; 24, buccal nerve; 25, buccal or inferior buccolabial branches of facial nerve; 26, pes anserinus or parotid plexus; 27, mandibular or supramaxillary branch.

branches. This nerve arises from the second division anterior to the sphenopalatine branches; in other words, at a point approximately 5 mm. distal to the posterior floor of the orbit, and it has a diameter of approximately 1 mm. Its course is downward, forward and laterally (see Figs. 48, 43, 54-*A* and 60). It enters the posterior superior dental foramen or foramina upon the posterior lateral tuberosity of the superior maxillary bone, at a point approximately 2 cm. above the distogingival margin of the upper third molar. (See Figs. 36, 37, 60, and 68.) After this nerve enters the superior maxillary bone at a point as above stated, it passes anteriorly into the middle plate of bone comprising the alveolar process, giving off small branches which enter the apices of the roots of the second and third molar teeth, and in some cases the apices of the roots of the upper first molar tooth. (See Figs. 40 and 60.) However, the nerve supply of the first molar tooth varies, as part of it may come from the posterior superior alveolar and a part from the middle superior dental, or its entire supply may come from the middle superior alveolar. This nerve anastomoses with the middle superior dental, consisting in the formation of a dental or alveolar plexus which is located above the apices of the roots of the upper molars, first and second bicuspid teeth. (See Figs. 40 and 60.) It also assists in forming the posterior portion of the outer nerve loop, which will be discussed later.

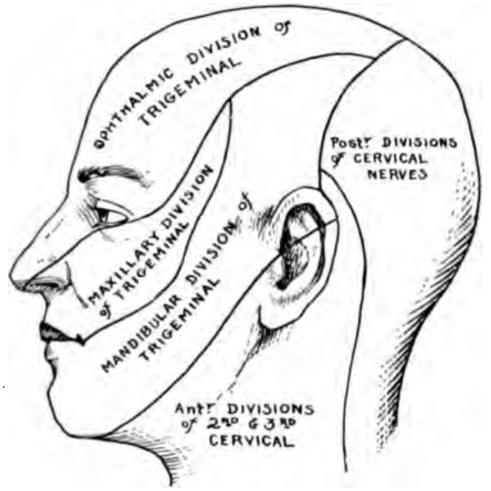

OPHTHALMIC DIVISION of TRIGEMINAL
MAXILLARY DIVISION of TRIGEMINAL
MANDIBULAR DIVISION of TRIGEMINAL
Postr DIVISIONS of CERVICAL NERVES
Antr DIVISIONS of 2nd & 3rd CERVICAL

Fig. 58.- Illustrating the various areas which are supplied by the various divisions of the fifth cranial nerve and the cervical plexus. (Redrawn from Gray.)

As the posterior superior dental nerve passes through the posterior superior alveolar foramen, it is accompanied by the posterior superior alveolar artery, which is a branch of the internal maxillary artery. (See Fig. 67.) In some cases this artery and nerve are located in the mucous membrane lining, the posterior wall of the antrum, and in the dry skull it is many times possible to see a small groove in the wall of the antrum which was occupied by these structures. In addition to supplying the upper second and third molar in some cases a portion of the upper first molar, this nerve branch su the buccal gum tissue and periosteum, mucous membrane of the mucous buccal side of the upper named teeth, and in addition the alveolar proc the immediate region. *This nerve branch does not supply the gum tissue, cous membrane and periosteum situated on the lingual side of the above te*

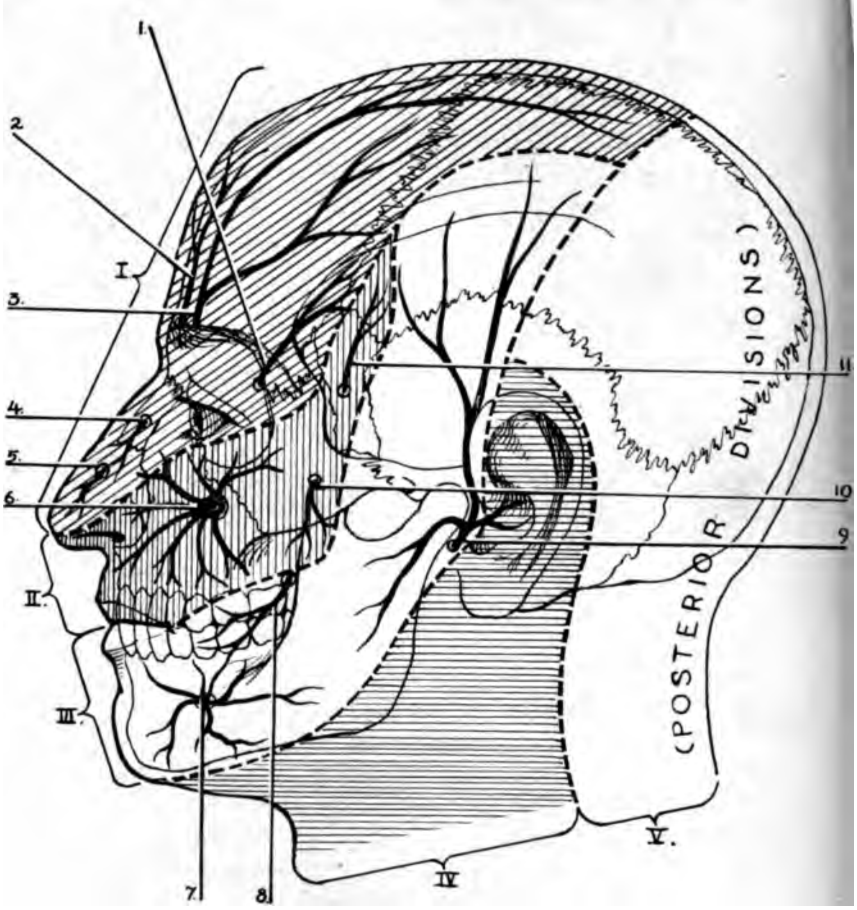


Fig. 59.—Sensory areas of the head, showing the general distribution of the three divisions of th facial nerve. (Redrawn from Gerrish.)

I, ophthalmic area; II, maxillary area; III, mandibular area; IV, superficial cervical plexus V, cervical nerves (posterior division); 1, lacrimal nerve; 2, supratrochlear nerve; 3, supraorbital 4, infratrochlear nerve; 5, nasal nerve; 6, infraorbital nerve; 7, mental nerves; 8, long buccal 9, auriculotemporal nerve; 10, malar branch of the temporo-malar; 11, temporal branch of the te nerve.

The Zygomatic Nerve

Another small branch, which is given off the second division in pterygopalatine fossa, is a zygomatic branch (orbital), and enters the ca of the orbit by way of the infraorbital fissure, and passes through zygomaticofacial canal of the malar bone (zygomatic bone) and emerges

the face through the zygomaticoorbital foramen, at which point it anastomoses with the lachrymal nerve. (See Figs. 53, 54-*A*, and 60.) As it emerges from the foramen upon the face, it divides into two branches, which are the zygomaticofacial which, after passing through the substance of the zygomatic or temporal bone, appears upon the face and supplies the skin covering the zygomatic bone, and anastomoses with small malar branches of the seventh cranial nerve. (See Figs. 56, 57, and 60.)

Infraorbital Nerve

The last large nerve branch which is given off within the sphenomaxillary fossa is the infraorbital, which is a continuation of the second division and is a terminal branch. It enters the infraorbital canal at the posterior part of the floor of the orbit, then traverses the infraorbital canal (see Figs. 60, 62, and 68). The nerve finally makes its exit upon the face through the infraorbital foramen, which is located at a point one centimeter beneath the infraorbital margin of the orbit. (See Figs. 35, 60, 70, and 71.) As the infraorbital nerve passes through the infraorbital canal, it gives off the middle and anterior superior alveolar nerves, which will be discussed later.

The accompanying diagram should give the reader a clear knowledge of the nerve branches located within the pterygopalatine fossa:

BRANCHES GIVEN OFF WITHIN THE PTERYGOPALATINE FOSSA.
- Two sphenopalatine to Meckel's ganglion (sphenopalatine ganglion).
- Posterior superior dental (one or two branches) to upper second and third molar teeth and in some cases upper first molar. Also to alveolar process, buccal periosteum, gum tissue and mucous fold in region of upper named teeth and posterior part of antrum.
- Anastomoses with middle superior dental and aids in forming the dental plexus.
- ZYGOMATIC BRANCH
  - ZYGOMATICOFACIAL
    - Anastomosing branches to seventh cranial. Cutaneous branch to skin of upper part of cheek.
    - Cutaneous branch to part of lower eyelid.
  - ZYGOMATICOTEMPORAL
    - Connecting branch with lachrymal nerve which is secretory.
    - Anastomosing branch with seventh cranial nerve.
    - Cutaneous branch to skin, face, anterior part of temple, and lateral part of forehead.
- INFRAORBITAL NERVE
  - This nerve is a continuation of the second division and gives off several branches, as is illustrated in diagrams on pages 100 and 102.

The branches which arise from the infraorbital nerve as it courses anteriorly through the floor of the orbit from the pterygopalatine fossa until it emerges through the infraorbital foramen upon the face are two in number. The divisions and subdivisions of these two branches are given in detail in the diagram on page 100. The infraorbital nerve is from 2 to 2½ mm. in diameter as it enters the orbit, and is purely sensory.

BRANCHES GIVEN OFF INFRAORBITAL NERVE WITHIN INFRAORBITAL CANAL

The Middle Superior Dental (Alveolar) Nerve

The middle superior dental nerve arises from the infraorbital nerve within the infraorbital canal, and it courses downward laterally and slightly forward, being located in the outer wall of the maxillary sinus, but during its course, it gives off many small branches which supply sensation to the mucous membrane lining the antrum at this point. (See Figs. 40, 60, and 68.) Before it reaches the antrum it passes through a small bony canal in the wall of the maxillary sinus. When it reaches the region of the alveolar process above the apices of the roots of the upper first and second bicuspid teeth and first molar tooth, it divides into several branches which supply a part of the mucous membrane in the floor of the antrum, the alveolar process located in the region of the two superior bicuspids and first molar teeth, buccal periosteum, gum tissue and mucous fold located on the buccal side of the upper named teeth. Small branches enter the apices of the superior first and second bicuspids, and in nearly all cases the roots of the upper first molar. (See Figs. 40 and 60.)

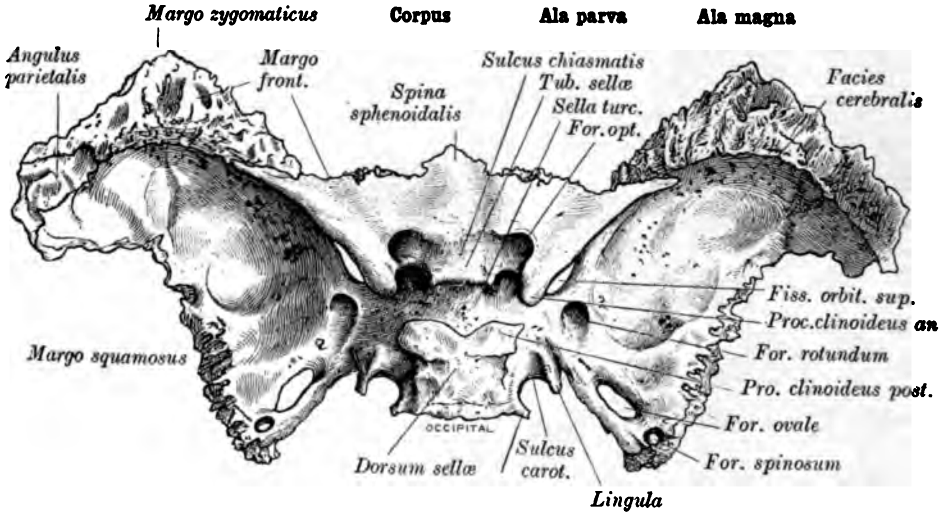


Fig. 61.—Sphenoid bone from above. (From Quain.)

It has been the author's experience that the superior bicuspids and first molar, alveolar process and soft tissues, located on the buccal side, are supplied with sensation in at least 95 per cent of the cases by the middle superior dental. This nerve anastomoses with the posterior and anterior superior dental branches and assists in the formation of the dental plexus, which is located directly over this zone, as previously described. It also enters into the formation of the outer nerve loop which will be described later.

Cunningham states that the middle superior dental may be a secondary branch which is given off the anterior superior alveolar, but it is the author's opinion that this seldom occurs, and he has been convinced of this fact, by conclusions based not only upon the results obtained from numerous nerve blocking injections, but from investigations made upon cadavers in the dissecting room.

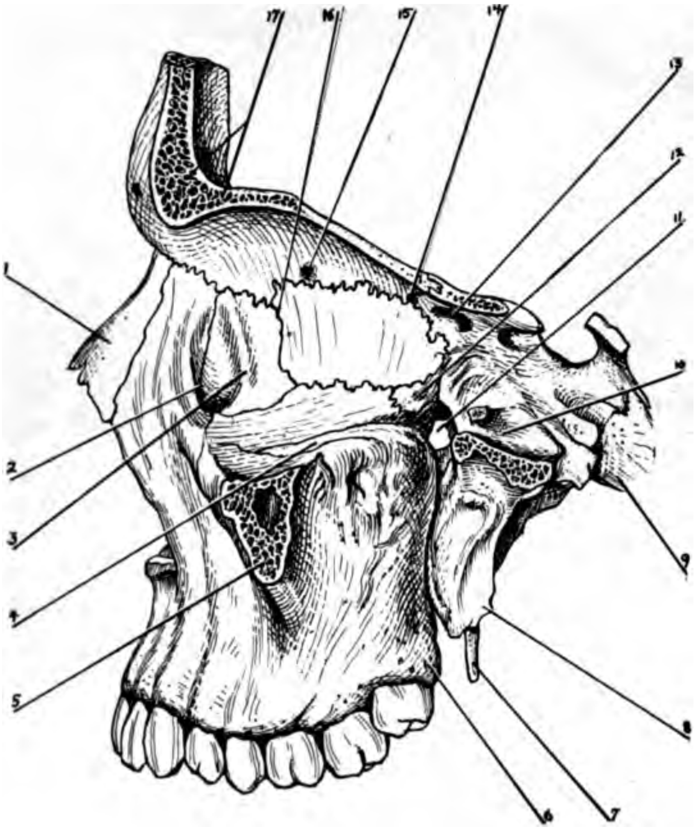


Fig. 62. -Lateral view of the superior maxillary bone and orbital cavity. (Redrawn from Sobotta-McMurrich.)

1, Nasal bone; 2, nasolacrimal canal; 3, posterior lacrimal crest; 4, infraorbital groove; 5, zygomatic process; 6, tuberosity; 7, hamular process; 8, external pterygoid plate; 9, body of sphenoid bone; 10, foramen rotundum; 11, sphenopalatine foramen; 12, orbital process of palate bone; 13, optic foramen; 14, posterior ethmoidal foramen; 15, anterior ethmoidal foramen; 16, lacrimal ethmoidal suture; 17, frontal bone.

Anterior-Superior Dental (Alveolar) Nerve.—This nerve branch arises from the infraorbital nerve. The author has found that this nerve branch is given off in most cases at a point approximately 5 mm. distal to the opening of the infraorbital foramen. This nerve branch passes downward and forward within the anterior wall of the antrum of Highmore until it reaches an area above the apices of the central, lateral, and cuspid teeth. In its course downward in the mucous membrane and bone, forming the anterior wall of the antrum, it gives off small sensory branches which supply these structures with sensation. When it reaches an area above the zone occupied by the central, lateral, and cuspid teeth, it divides into a dental branch and a nasal branch.

The Dental Branch.—The dental branch, in addition to supplying the mucous membrane and thin bone comprising the anterior wall of the antrum, supplies sensation to the central, lateral and cuspid teeth, alveolar process, labial gum tissue, periosteum and mucous fold in the region of the above-named teeth. It anastomoses freely with the middle superior dental nerve to form the superior dental plexus and with its fellow across the median line.

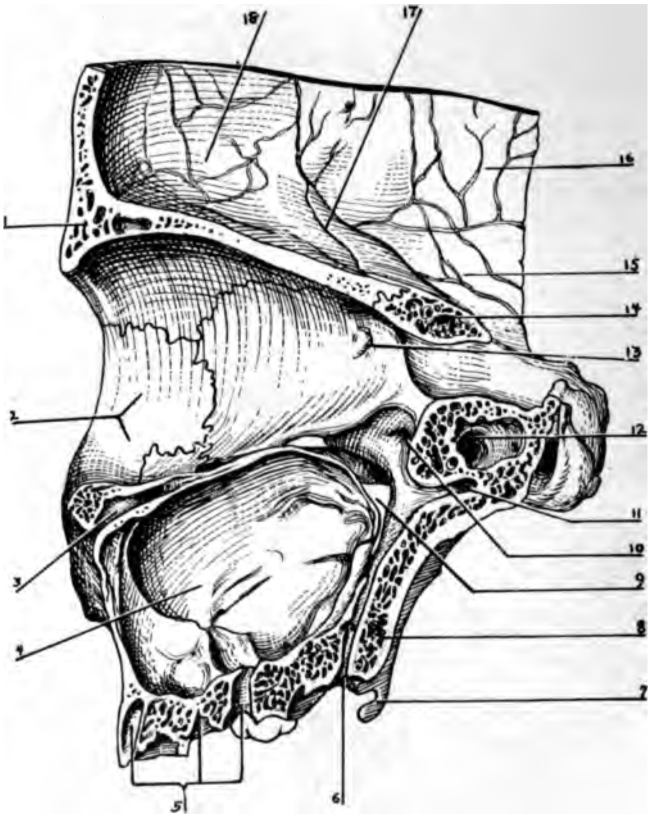


Fig. 63.--Medical section of superior maxillary bone showing the antrum and orbital cavity. (Redrawn from Sobotta-McMurrich.)

1, Frontal bone; 2, zygomaticoorbital foramina; 3, infraorbital canal; 4, maxillary sinus; 5, alveolar socket; 6, pterygoid canal; 7, hamular process; 8, pterygoid process; 9, pterygoid fossa; 10, foramen rotundum; 11, pterygoid canal; 12, sphenoidal sinus; 13, spine for external rectus; 14, lesser wing of sphenoid; 15, squamous portion of the temporal bone; 16, parietal bone; 17, sphenofrontal suture; 18, frontal bone (cerebral surface).

The Nasal Branch.—The nasal branch supplies the floor of the nasal fossa and the anterior portion of the inferior meatus and anastomoses with the nasopalatine nerve, which is a branch of Meckel's ganglion.

The anterior superior dental is one of the nerve branches, assisting in the formation of the outer nerve loop, which will be discussed later. At this point, the author wishes to call attention to the fact that the anterior zone, which is occupied by the central, lateral, and cuspid teeth, is supplied by the anterior superior dental; the middle zone which is occupied by the upper first and second bicuspids and first molar teeth is supplied by the middle superior dental. The posterior zone which is occupied by the upper second and third

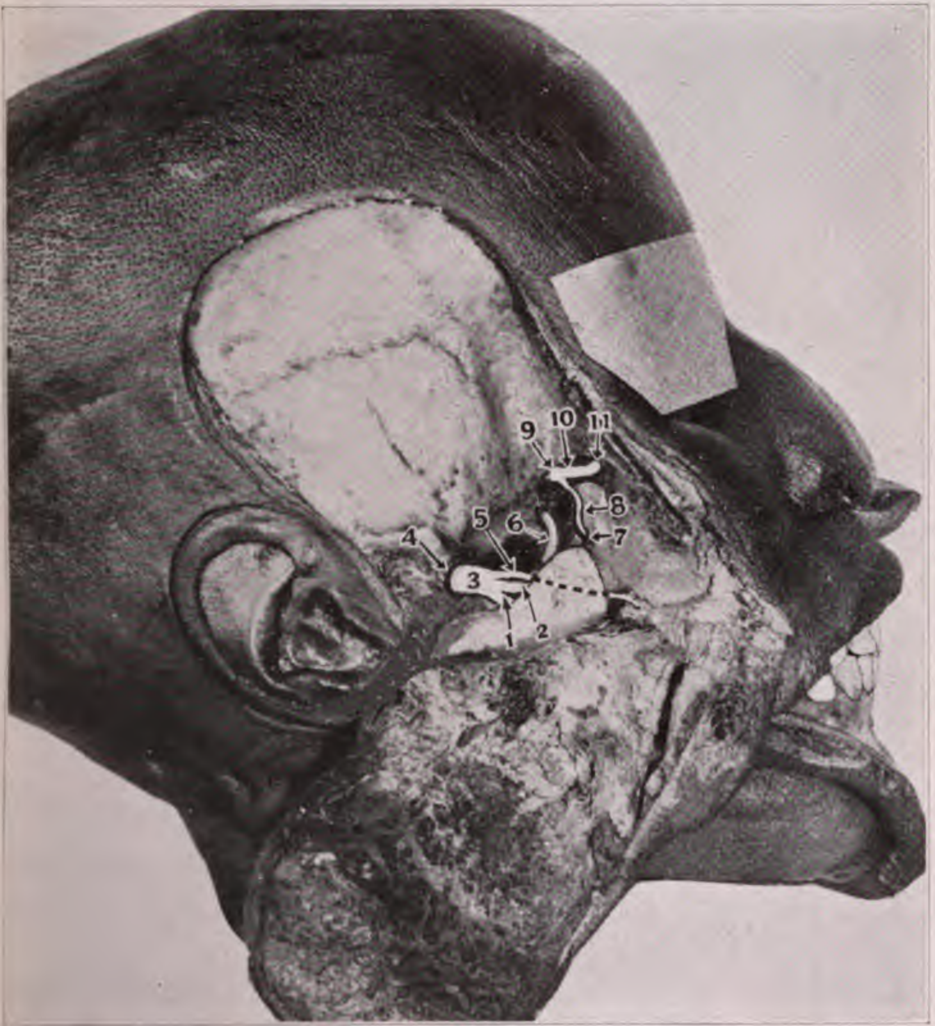


Fig. 64.—Wet anatomical specimen illustrating the following structures:

1, Inferior dental nerve; 2, lingual nerve; 3, mandibular nerve; 4, foramen ovale; 5, long buccal nerve; 6, internal maxillary artery; 7, posterior superior dental foramen; 8, posterior superior dental nerve; 9, foramen rotundum; 10, maxillary nerve; 11, maxillary nerve entering the posterior part of the infraorbital canal.

molar teeth is supplied by the posterior superior dental. (See diagram on page 100.) Emphasis is placed upon this point for the simple reason that the operator must have a definite knowledge of the nerve supply of the part upon which he wishes to operate. For example, he should not expect anesthesia in the middle zone by blocking the nerve supply to the anterior or posterior zones or vice versa.

The accompanying outline should assist the reader in obtaining an understanding of the divisions and subdivisions of the nerve supply in this region.

- BRANCHES GIVEN OFF INFRAORBITAL NERVE WITHIN INFRAORBITAL CANAL.
  - MIDDLE SUPERIOR DENTAL (ALVEOLAR)
    - To antrum of Highmore, mucous membrane and bone.
    - To apices of upper first and second bicuspids and in 95 per cent of cases the upper first molar.
    - To alveolar process in region of upper named teeth, buccal gum tissue, periosteum and mucous fold.
    - Anastomoses with posterior and anterior superior alveolar branches to form superior dental plexus.
  - ANTERIOR SUPERIOR DENTAL (ALVEOLAR)
    - Dental branch
      - To antrum of Highmore.
      - To superior central, lateral and cuspid teeth.
      - To alveolar process, labial gum tissue, periosteum, mucous fold in region of above-named teeth.
      - Anastomoses with middle superior alveolar to form superior dental plexus and with its fellow across the median line.
    - Nasal branch
      - To floor nasal fossa and anterior portion of inferior meatus.
      - Anastomoses with nasopalatine nerve.
  - The infraorbital nerve passes through infraorbital foramen on face and divides into three facial branches which are described below.

BRANCHES GIVEN OFF THE INFRAORBITAL NERVE UPON THE FACE

Inferior Palpebral, External Nasal, and Superior Labial Nerve Branches

The branches arising from the infraorbital nerve in the region of the face, after it emerges from the infraorbital canal through the infraorbital foramen, are three in number—the inferior palpebral, external nasal, and superior labial (see Figs. 40, 59, 60, 69, and 70). These nerves are located beneath the quadratus labii superioris muscle. Soon after the infraorbital nerve passes out of the infraorbital foramen upon the face, its branches communicate with small branches from the seventh cranial nerve (facial nerve) and form the infraorbital plexus, which is located beneath the musculus zygomaticus, and the quadratus labii superioris, that is, immediately below its point of origin (see Fig. 74). This plexus is surrounded by connective and fatty tissue. A vein and artery of the same name as the nerve pass through the infraorbital foramen upon the face. The infraorbital plexus gives off the three branches above named. All three branches divide up into many small branches and form more or less a fan-shaped arrangement. (See Fig. 69.)

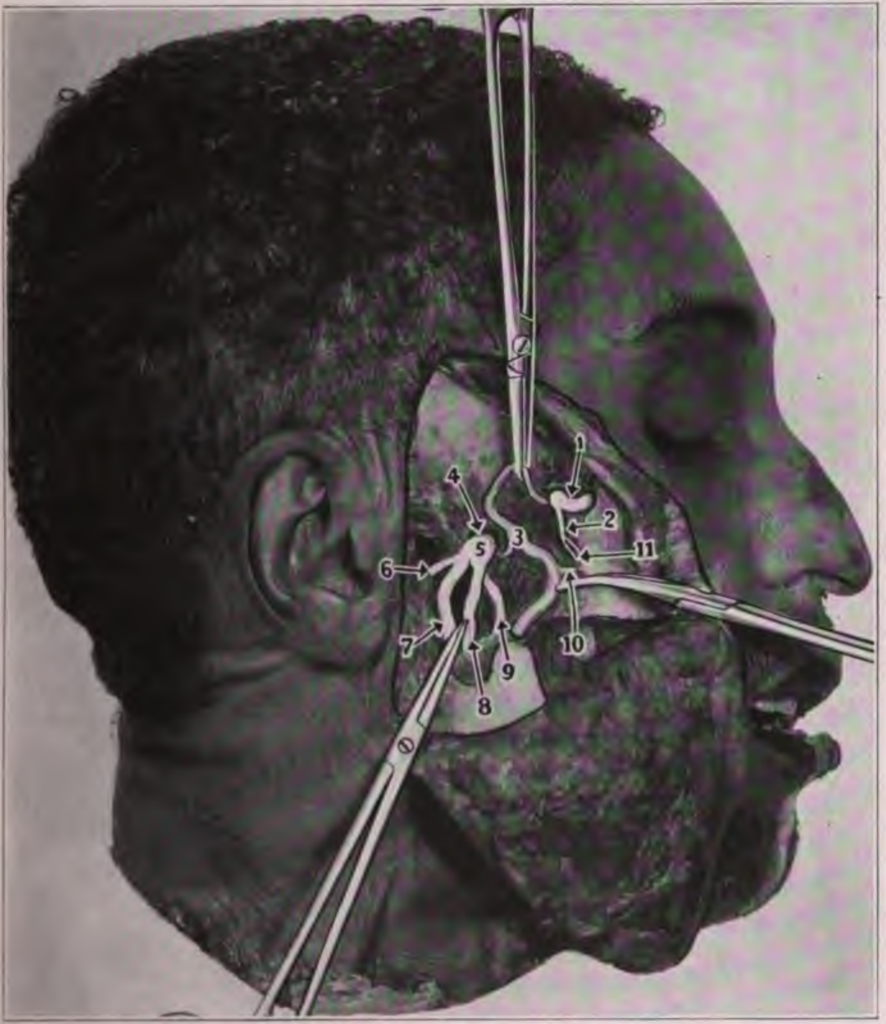


Fig. 65.—Wet anatomical specimen illustrating the following structures:

1, Maxillary nerve, second division of fifth; 2, posterior superior dental; 3, internal maxillary artery; 4, foramen ovale; 5, mandibular nerve; 6, auriculotemporal nerve; 7, inferior dental nerve; 8, lingual nerve; 9, long buccal nerve; 10, posterior superior alveolar artery; 11, posterior superior alveolar nerve and artery at posterior superior alveolar foramen.

The inferior palpebral branch passes upward, giving off small branches which supply the conjunctiva, skin of the lower eyelid, as well as connecting with the infraorbital plexus and facial nerves. The external branch runs medially to the nose and supplies the mucous membrane lining the vestibule in the region of the ala, as well as supplying the ala itself. The superior labial branch descends to the upper lip, supplying the lip, a portion of cheek and mucous membrane in this region.

If the accompanying diagram is studied by the reader, he should obtain a clear understanding of the division of nerves after the infraorbital nerve has emerged from the infraorbital foramen upon the face:

BRANCHES GIVEN OFF FROM INFRAORBITAL NERVE IN REGION OF FACE	INFERIOR PALPEBRAL	To infraorbital plexus with seventh cranial nerve. To conjunctiva and skin of lower eyelid.
	EXTERNAL NASAL	To ala and mucous membrane lining the vestibule in region of ala. To skin of posterior inferior part of side of nose.
	SUPERIOR LABIAL	To skin, mucous membrane of superior lip and cheek. Communicates with infraorbital plexus with seventh cranial nerve.

The Outer Nerve Loop and Superior Dental Plexus

The superior dental plexus is composed of nerves derived from the posterior, middle and anterior superior alveolar nerve branches and is situated between the floor of the antrum and the root of the upper first and second bicuspid and first molar teeth (see Figs. 40 and 60). In most cases this dental plexus gives off two distinct branches, the first one being the superior dental rami, which passes to the apices of the roots of the above-named teeth, and the superior gingival rami, which enter the alveolar septa and supply the buccal gum tissue, periosteum, mucous membrane, maxillary sinus, etc.

The nervous arrangement at this point is extremely complex and many small branches are given off which connect with each other at varying points.

In the young subject, the dental plexus can be blocked by infiltration or terminal anesthesia, but in the older subjects, who possess a dense external alveolar plate, excellent results can be obtained from the intraosseous method of anesthesia, and immediate anesthesia of the three teeth located in this zone as well as the alveolar process and buccal tissue is obtained.

There are two nerve loops situated in the upper jaw, that is, two on either side, which are called the internal and external. The inner nerve loop is formed by the anterior palatine and nasopalatine nerve branches which arise from Meckel's ganglion in the pterygopalatine fossa. The inner nerve loop will be discussed in detail later.

The outer nerve loop is formed by the posterior, middle, and anterior superior alveolar nerves. The middle and anterior branches arise from the infraorbital nerve, while the posterior branch arises from the second division in the pterygopalatine fossa.

To summarize what has been said with reference to the three branches comprising the outer nerve loop, is that they supply the teeth in the corresponding half of the jaw, buccal and labial alveolar process, periosteum, gum tissue, and mucous fold, having nothing to do with the nerve supply on the lingual aspect of these teeth. Therefore, if the operator desires to remove pulps from the teeth, prepare abutments for crowns or bridgework, prepare cavities, or do other operations, which involve the teeth, buccal or labial structures, it is not necessary to block the nerve branches situated on the lingual side. However, if the teeth are to be extracted, then it becomes necessary not only to block the outer nerve loop or a portion of it, depending upon the location of the tooth to be removed, but also to block the nerve supply on the lingual side. The operator must be his own judge as to what nerves to block, and if he understands his anatomy he will know exactly what to do in each individual case, and will make only those injections which are necessary. Note the accompanying diagram.

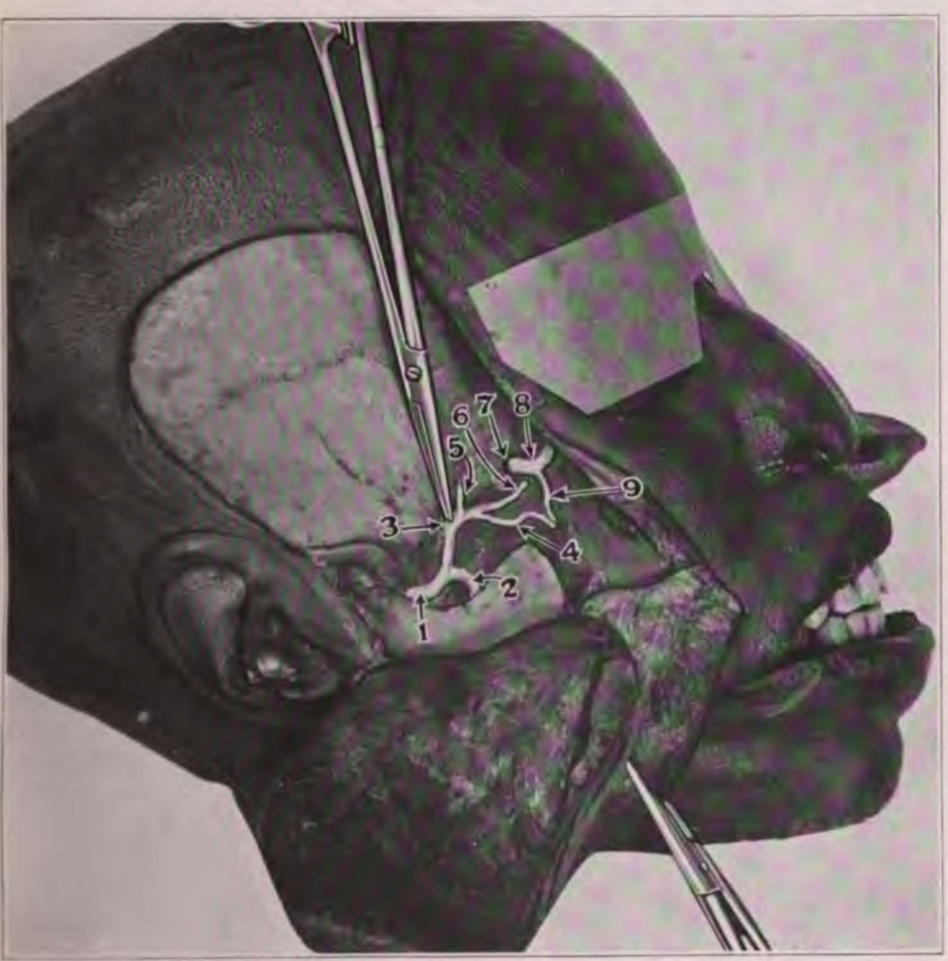


Fig. 66.—Prepared anatomatical specimen illustrating the following structures:

1, Internal maxillary artery; 2, inferior dental artery; 3, branch of internal maxillary artery; 4, posterior superior dental artery; 5, sphenopalatine artery; 6, infraorbital artery; 7, foramen rotundum; 8, second division of fifth nerve; 9, posterior superior dental nerve.

BRANCHES FORMING OUTER OR EXTERNAL NERVE LOOP	Posterior superior dental	Form superior dental plexus.
	Middle superior dental	
	Anterior superior dental	
OUTER OR EXTERNAL NERVE LOOP SUPPLIES	Teeth on corresponding side of jaw.	
	Alveolar process.	
	Buccal and labial periosteum and gum tissue.	
	Buccal and labial mucous membrane.	
	Buccal and labial mucous fold of cheek and lips.	
	If operation is to extend to median line the overlapping nerve branches at this point must be blocked.	

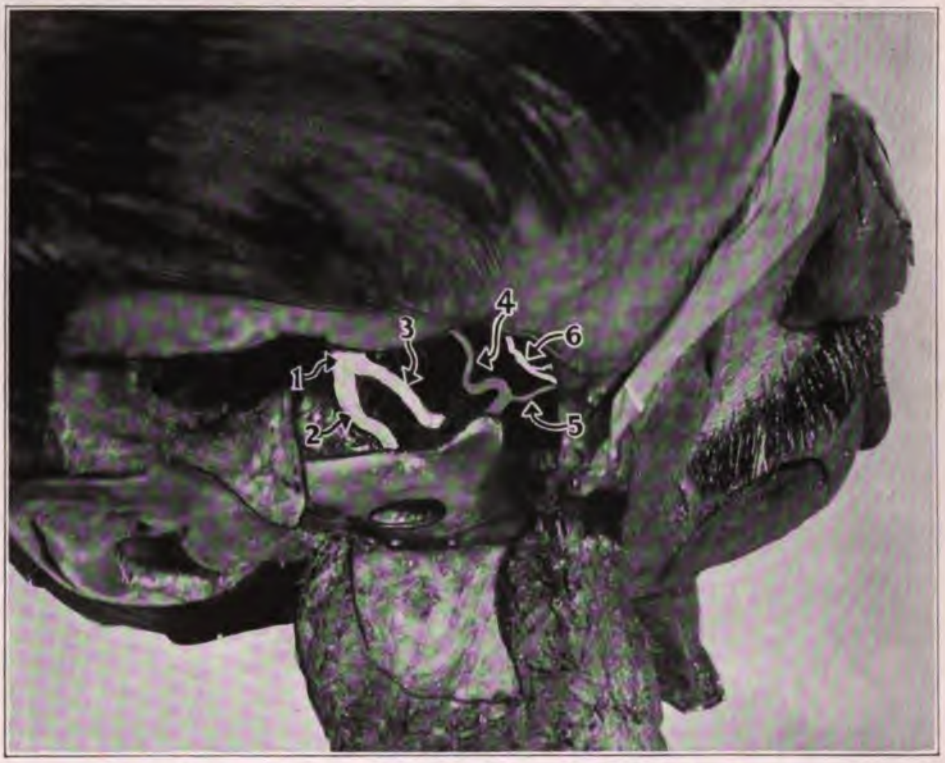


Fig. 67.—Prepared anatomical specimen illustrating the following structures:

1, Mandibular nerve; 2, inferior dental nerve; 3, lingual nerve; 4, internal maxillary artery; 5, posterior superior dental artery and 6, posterior superior dental nerve.

The Sphenopalatine Ganglion (Meckel's Ganglion).—The sphenopalatine ganglion is situated in the pterygopalatine fossa, located about midway between the anterior surface of the sphenoid bone and the posterior border of the maxillary bone, and 5 or 6 mm. beneath the second division of the fifth nerve as this branch bridges the pterygopalatine fossa. (See Figs. 40, 48, 60, 77, 78, 79, and 118.) Its shape is either rounded or triangular and is suspended from the trunk of the second division by the two sphenopalatine nerves which form the sensory part of the ganglion.

The sympathetic and motor fibers, which form the respective roots of this ganglion, originate from the nerve located in the pterygoid canal. (Vidian nerve.)

Vidian Nerve (Nerve of Pterygoid Canal).—The Vidian nerve courses along the pterygoid canal, which is located in the pterygoid process of the sphenoid bone and, in reality, it consists of two nerves which macroscopically appear as one nerve. (See Figs. 60 and 77.) Under one sheath they course through the pterygoid canal, one consisting of motor fibers, the other of sympathetic fibers, each going to form the respective roots of the sphenopalatine ganglion. This nerve is formed within the skull, near the foramen lacerum, by the union of two branches. One branch, which is sympathetic in function, is given off the carotid plexus, on the internal carotid artery, and is known as the deep petrosal nerve, while the other branch, which is motor in function,

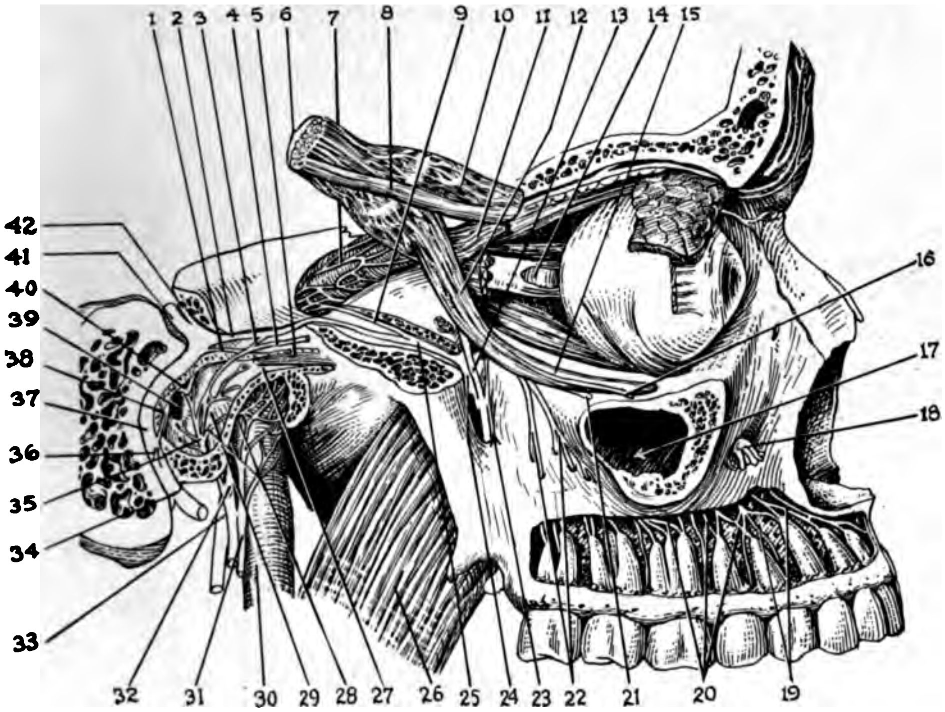


Fig. 68.—The second branch of the trigeminal nerve, the sphenopalatine ganglion; the intracranial portion of the facial and tympanic nerves. (Redrawn from Sobotta-McMurrich.)

1, Anastomosis between facial and tympanic nerves; 2, great superficial petrosal nerve; 3, anastomosis between great superior petrosal to tympanic nerves; 4, lesser superficial petrosal nerve; 5, tensor tympani; 6, trigeminal nerve; 7, internal carotid plexus; 8, portiominor; 9, deep petrosal nerve; 10, mandibular nerve; 11, ophthalmic nerve; 12, maxillary nerve; 13, sphenopalatine nerve; 14, optic nerve; 15, infraorbital nerve; 16, zygomatic nerve; 17, maxillary sinus; 18, infraorbital nerve; 19, anterior superior alveolar nerves; 20, middle superior alveolar nerve; 21, middle superior alveolar nerve; 22, posterior superior alveolar nerve; 23, pterygopalatine fossa; 24, sphenopalatine ganglion; 25, nerve of pterygoid canal; 26, internal pterygoid muscle; 27, tuba auditiva; 28, caroticotympanic nerve; 29, tympanic antrum; 30, internal carotid artery; 31, internal carotid nerve; 32, petrous ganglion of glossopharyngeal; 33, vagus nerve; 34, stylomastoid foramen; 35, tympanic nerve; 36, chorda tympani; 37, facial nerve; 38, stapedius; 39, tympanic sinus; 40, stapes; 41, facial nerve; 42, intermediate nerve.

arises from the geniculate ganglion, located on the facial nerve, and is called the greater superficial petrosal nerve. These two branches unite and pass through the pterygoid canal and are known as the Vidian nerve. The new term given this nerve is *nervus canalis pterygoidei*. (See Fig. 77.)

The Vidian nerve is short and simply acts as a connecting link between the seventh cranial nerve and sympathetic nervous system, and the sphenopalatine ganglion and supplies this ganglion with its motor and vasomotor roots. Therefore, the sphenopalatine or Meckel's ganglion is composed of

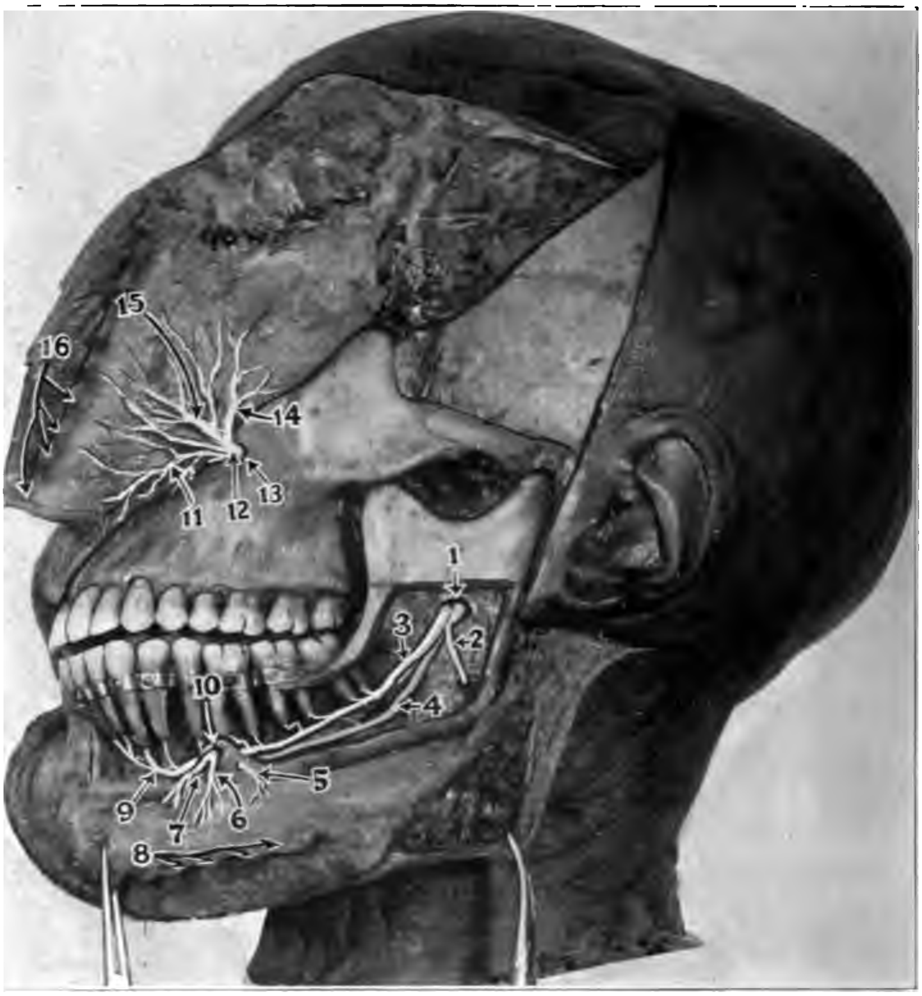


Fig. [illegible]. Wet dissected specimen illustrating the following structures:

1, Inferior dental foramen; 2, inferior dental vein; 3, inferior dental nerve; 4, inferior dental [illegible]; 5, [illegible]; 6, [illegible] of mental nerve; 7, anterior ramus of mental [illegible] [illegible] of lower teeth; 9, incisive nerves; 10, [illegible]; 11, [illegible] labial nerve; 12, infraorbital nerve; 13, infraorbital foramen; [illegible]; 15, [illegible] nasal nerve; 16, gingival margin of tissue located buccal and [illegible] teeth.

three kinds of fibers or roots: *first*, a sensory, by way of the two spheno-palatine nerves, connecting it with the second or maxillary division of the fifth nerve; *second*, a motor branch, by way of the large superficial petrosal, and the Vidian nerve connecting it with the seventh cranial or facial; *third*, the sympathetic system through the large deep petrosal nerve which arises from the carotid plexus.

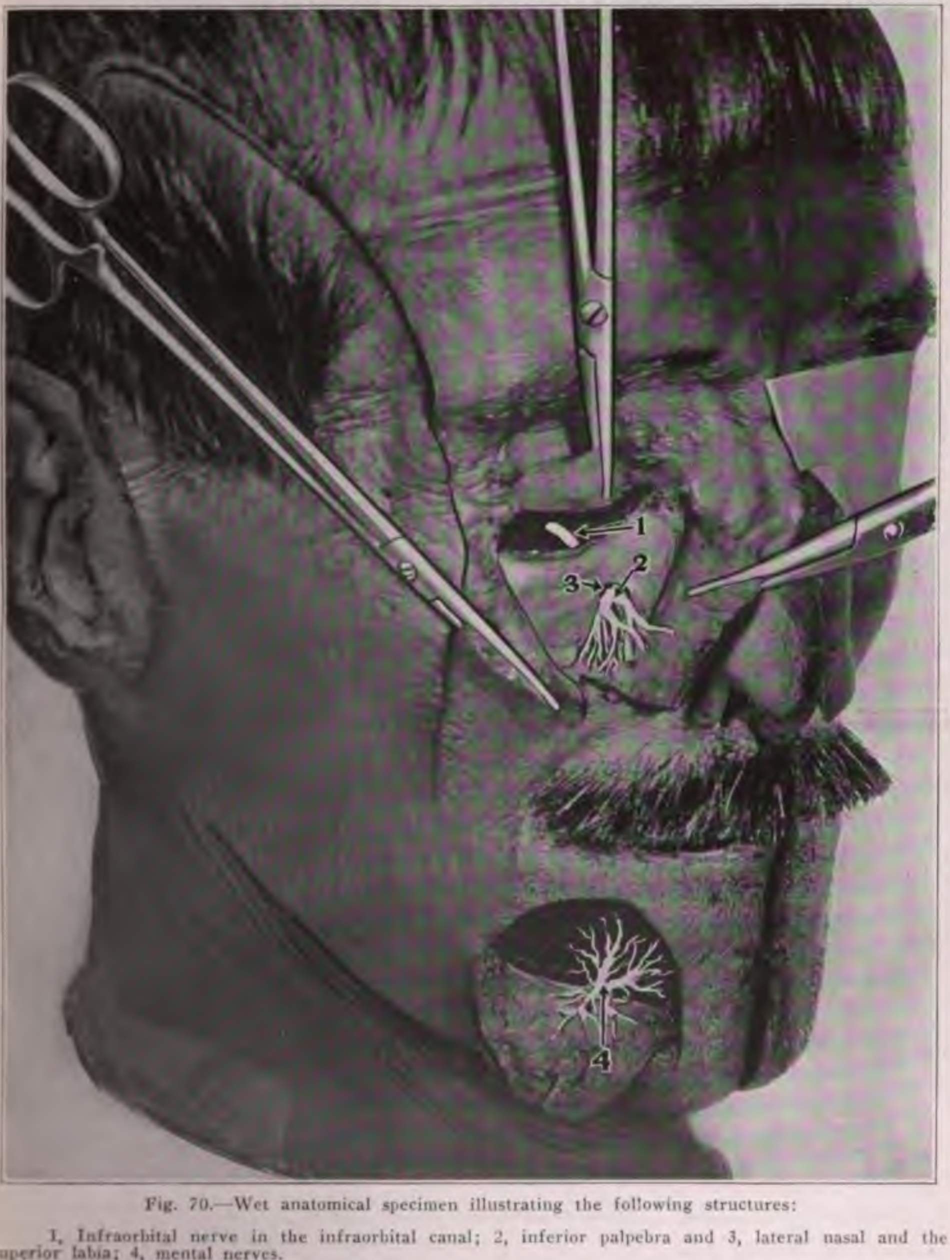


Fig. 70.—Wet anatomical specimen illustrating the following structures:

1, Infraorbital nerve in the infraorbital canal; 2, inferior palpebra and 3, lateral nasal and the superior labia; 4, mental nerves.

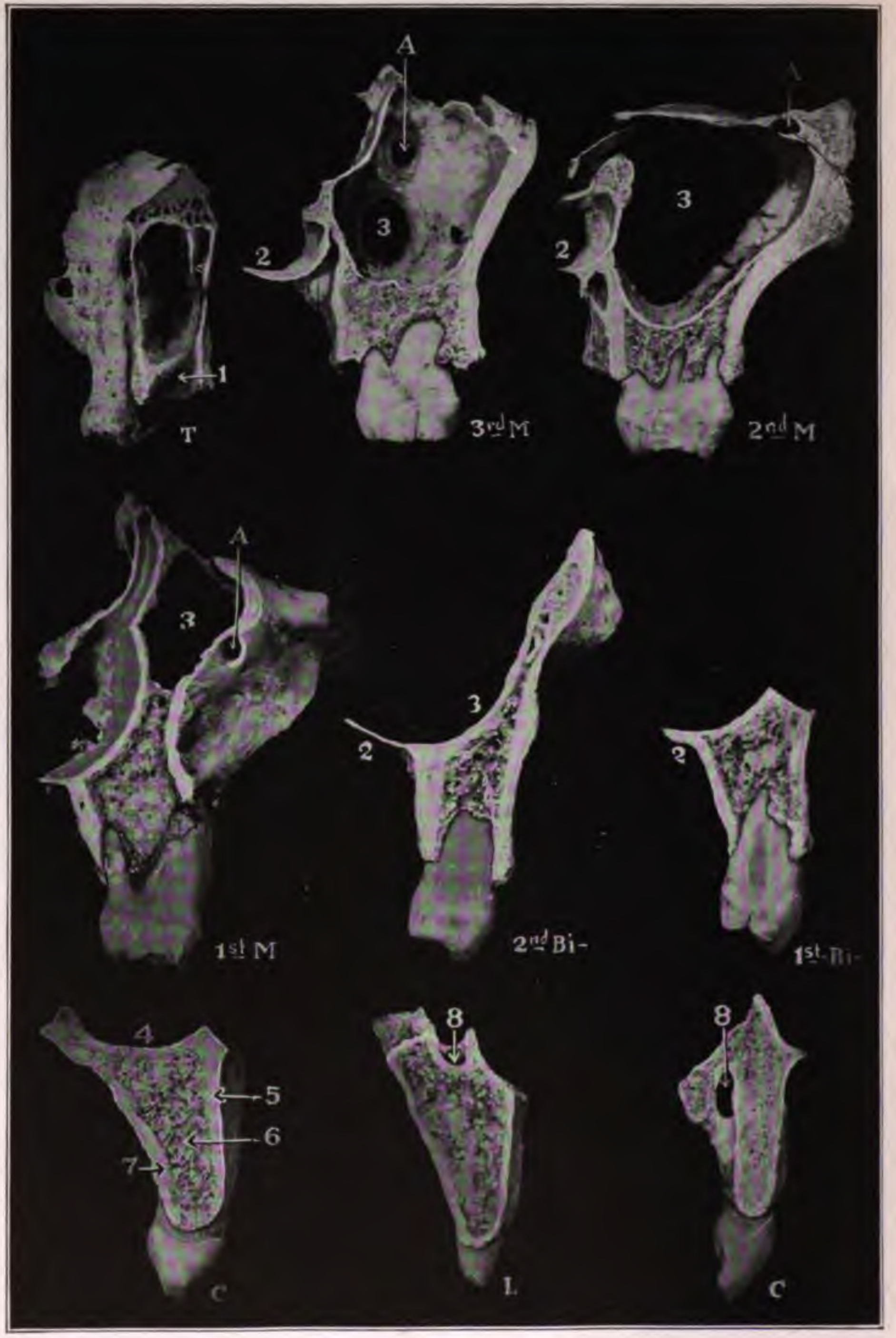


Fig. 71.—Superior maxillary bone which has been incised through the superior maxillary sinus and between the various teeth.

A, infraorbital foramen and canal; T, tuberosity of superior maxillary bone; C, central incisor; L, lateral incisor; C, cuspid. 1, Pterygoid plate; 2, floor of nasal cavity and hard palate; 3, maxillary sinus; 4, nasal cavity; 5, external alveolar plate; 6, middle table or intercancellous bone; 7, lingual plate; 8, anterior palatine canal.

The following diagram shows the origin as well as the names of nerves connected with this ganglion.

ROOTS OF SPHENOPALATINE (MECKEL'S) GANGLION FORMED BY:

- Sphenopalatine branches from second division which are sensory in function.
- Vidian (nerve of the pterygoid canal) formed by greater superficial petrosal which is motor and deep petrosal which is sympathetic.

- Large, deep petrosal from carotid plexus (sympathetic).
- Great superficial petrosal from geniculate ganglion of seventh cranial or facial nerve (motor).
- Fibers to superior posterior part of nose and nasal septum, superior meatus and turbinate.

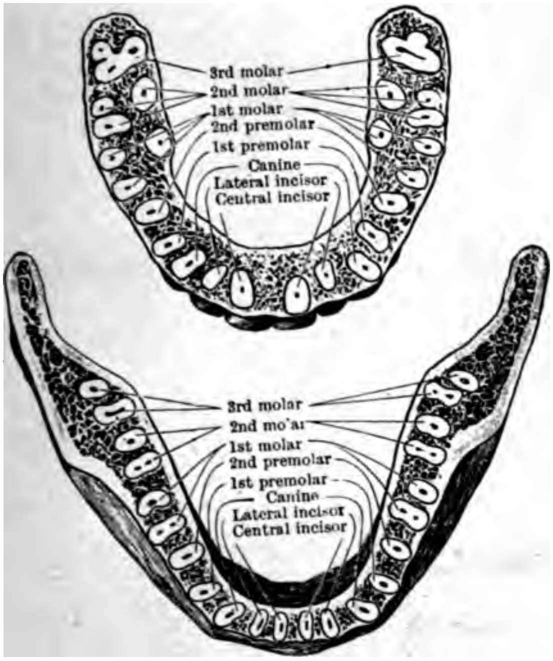


Fig. 72.—Horizontal sections through both the maxilla and mandible to show the roots of the teeth. The sections were carried through the bones a short distance from the edge of their alveolar borders. The upper figure shows the upper teeth, the lower figure the lower teeth. Note the flattened roots of the lower incisors, the two root-canals in the anterior root of each lower molar, and the confluence of the three roots of the upper last molars. (From Cunningham.)

There are four groups of branches given off Meckel's ganglion. They are more easily discussed under groups than separately. The four groups which are given off are as follows:

1. Internal or nasal group of branches.
2. Descending or palatine group of branches.
3. Posterior group of branches.
4. Anterior or orbital group of branches.

1. Internal or Nasal Group of Branches from Sphenopalatine Ganglion.—The internal or nasal branches are divided into two groups for descriptive purposes, which are as follows (see Fig. 78):

1. Posterior superior medial nasal branches, which pass through the sphenopalatine foramen, passing anteriorly across the upper part, or roof, of the nasal cavity, reaching the posterior part of the nasal septum, which it supplies together with the mucous membrane covering this part. There are a number of these branches; the largest of them is called the nasopalatine, which runs obliquely downward across the nasal septum from above, coursing its way anteriorly in a distinct groove, which is located on the surface of the perpendicular plate of the ethmoid and vomer bones.

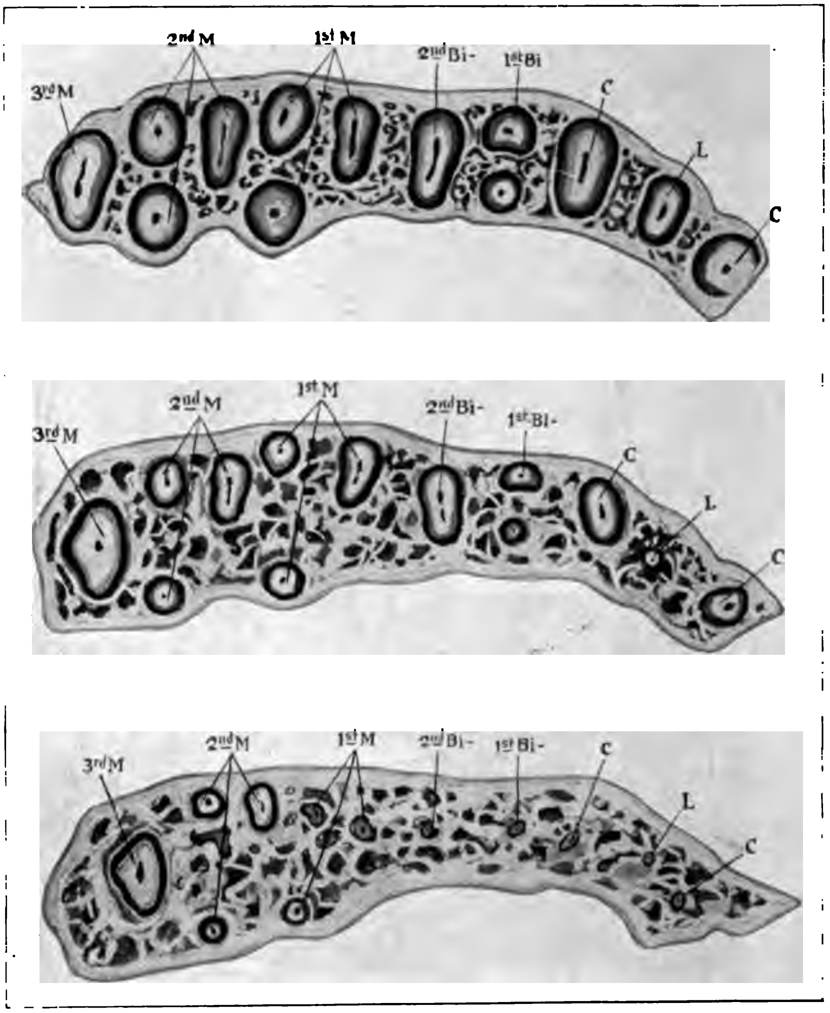


Fig. 73. Cross-sections of alveolar process of upper jaw, showing the teeth at three different planes

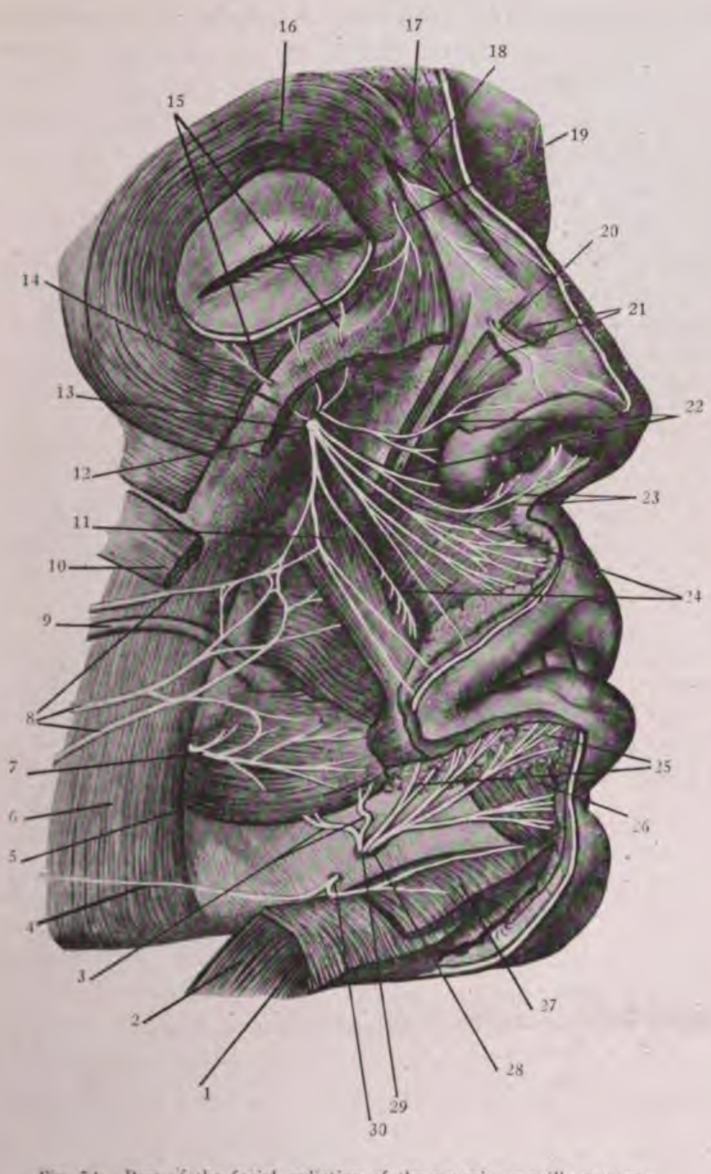


Fig. 74.—Part of the facial radiation of the superior maxillary nerve. (Retouched from Toldt.)

1, Depressor anguli oris or triangularis menti muscle (turned downwards); 2, platysma myoides (turned downwards); 3, branches of gum of lower jaw; 4, offset of mandibular or supramaxillary branch of facial nerve; 5, buccinator muscle; 6, masseter muscle; 7, buccal nerve; 8, malar branches of facial nerve; 9, parotid duct, or duct of Stensen; 10, zygomaticus major muscle; 11, levator anguli oris muscle or musculus caninus; 12, infraorbital nerve; 13, infraorbital foramen; 14, levator labii superioris alaeque nasi; levator labii superioris proprius, and zygomaticus minor muscles (cut short); 15, inferior palpebral branches; 16, orbicularis palpebrarum muscle; 17, frontalis muscle; 18, supratrochlear nerve; 19, infratrochlear nerve; 20, anterior or superficial branch of nasal nerve; 21, compressor naris muscle (cut across); 22, lateral nasal branches; 23, internal nasal branches; 24, superior labial branches; 25, inferior labial branches; 26, levator labii inferioris or levator menti muscle; 27, depressor labii inferioris or quadratus menti muscle (turned downwards); 28, mental or labial nerve; 29, mental foramen; 30, small branch of mental or labial nerve.

2. The second group of branches are called the posterior superior lateral nasal branches. These branches pass through the sphenopalatine foramen and supply the mucoperiosteum in the region of the superior nasal meatus, middle and superior nasal conchæ, sphenoidal sinus, and posterior ethmoidal cells. (See Figs. 77 and 79.)

The Nasopalatine Nerve

The nasopalatine nerve is a long branch and is easily found by dissection in the mucoperiosteum of the nasal septum. Its origin is from Meckel's ganglion and its general direction is downward anteriorly and slightly medial.

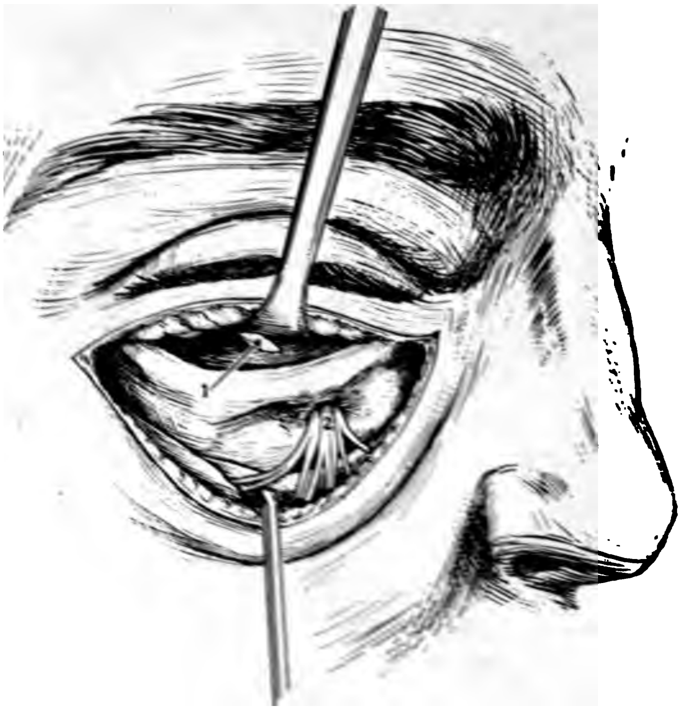


Fig. 78.—[illegible] peripheral endings of infraorbital nerve.

After it leaves Meckel's ganglion, it enters the nasal cavity by way of the sphenopalatine foramen (see Figs. 40, 60, and 68). It makes its exit into the mouth upon the hard palate, through the foramen of Scarpa. The two foramina of Scarpa open into the incisive foramen or anterior palatine foramen. (See Figs. 54 and 71.) The nasopalatine nerves from each side unite, at which point they form a plexus. The plexus gives off numerous small branches which supply the mucous membrane (periosteum) located on the lingual side of the central, lateral and cuspid teeth (see Figs. 67, 77, 79, 81, and 82). A branch of considerable size, however, passes backward and laterally in the region of the apices of the central, lateral and cuspid teeth, anastomosing with the anterior palatine branch, which is also given off Meckel's ganglion, thus forming the inner or medial nerve loop, which will be discussed later.

The following diagram shows the internal or nasal branches from the sphenopalatine ganglion:

- INTERNAL OR NASAL GROUP OF BRANCHES, FROM SPHENOPALATINE (MECKEL'S) GANGLION.
  - POSTERIOR SUPERIOR MEDIAL NASAL BRANCHES
    - To posterior and upper part of nasal septum.
    - Nasopalatine branch. Courses downward and forward in nasal septum.
      - Branches to gum tissue and periosteum lingual to superior incisor, lateral and portion of cuspid teeth on corresponding side.
      - Anastomoses with anterior palatine lingual to apex of superior cuspid tooth, thus forming inner or medial nerve loop.
      - Branches to nasal mucous membrane and septum.
  - POSTERIOR SUPERIOR LATERAL NASAL BRANCHES
    - To superior meatus posteriorly.
    - To superior and middle turbinate posteriorly.
    - To posterior part of nasal cavity.
    - To posterior ethmoidal cells and sphenoidal sinus.

The Descending or Palatine Group of Branches from the Spenopalatine Ganglion.—The descending group of palatine branches, which are given off from the sphenopalatine ganglion (Meckel's), comprise three large size nerves which are the anterior, middle and posterior palatine. These descending branches proceed from Meckel's ganglion in the pterygopalatine fossa and are incorporated in one nerve sheath with the posterior inferior nasal nerve. It is stated by most anatomists that these palatine branches proceed from Meckel's ganglion by a common trunk; however, in some cases they are given off separately. (See Figs. 60 and 78). These branches extend into the pterygopalatine canal and are enclosed by dense connective tissue.

The Anterior Palatine Nerve

The anterior palatine nerve is the largest branch of the three palatine nerves, and is the largest branch which is given off of the sphenopalatine ganglion. The course of this nerve is downward and forward, and it is situated in the pterygopalatine canal together with a branch of the internal maxillary artery. (See Figs. 40, 48, 60, 79, 80, 92, and 99.) This nerve is of good size and is easily blocked as it emerges from the posterior palatine foramen. The nerve emerges from the pterygopalatine canal upon the hard palate through the posterior palatine foramen, which is located about 15 mm. lingual to the linguogingival margin of the upper third molar (upper second molar in a child). In other words, it is located midway between the linguogingival margin of the third molar and median line. It emerges from the posterior palatine foramen with the greater palatine artery, and passes anteriorly at a point lingually corresponding to the apices of the lingual roots of the upper three molars and the apices of the roots of the two upper bicuspids until it reaches a point lingual to the apex of the upper cuspid tooth, at which point it communicates with the nasopalatine branch, forming the inner or medial loop. As this nerve courses anteriorly from its exit from the posterior palatine foramen to a point lingual to the apex of the upper

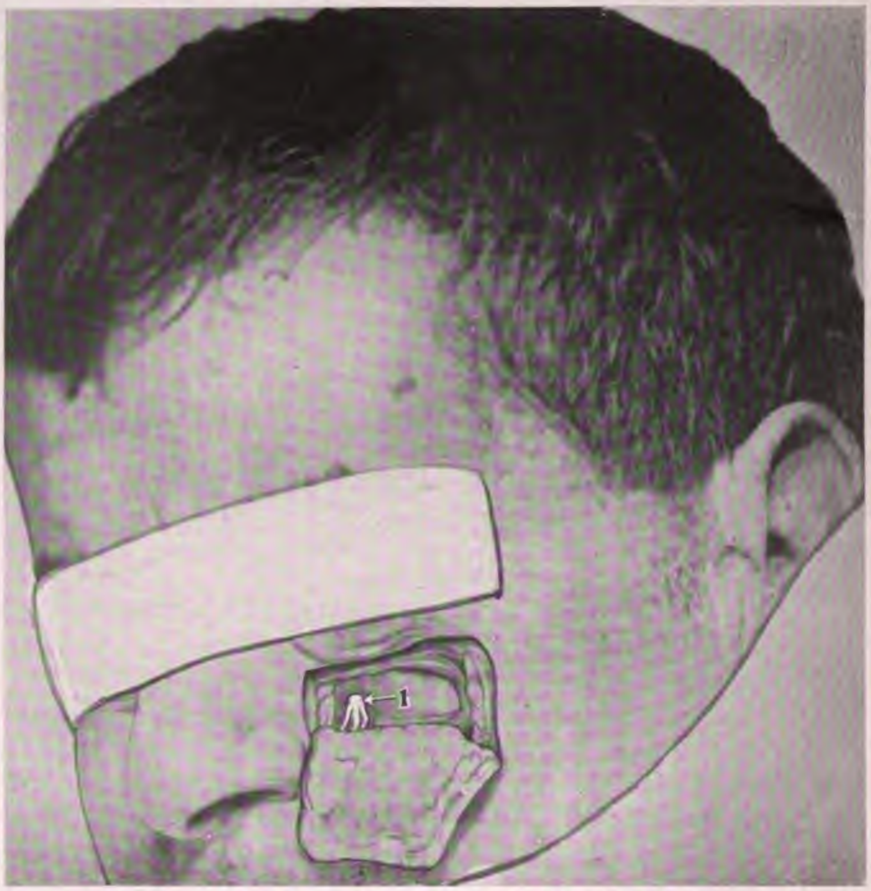


Fig. 76.—1, Infraorbital nerve exiting through the infraorbital foramen.

cuspid tooth, it gives off many small branches running both medially and laterally. The lateral branches pass laterally and downward, supplying the gum tissue and periosteum covering the linguoalveolar plate of the upper bicuspid and molar teeth. The medial branches pass medially and supply the mucoperiosteum, overlapping their fellow branches from the opposite side in the median line of the hard palate. In addition to supplying the mucous membrane and gum tissue on the lingual side of the above named teeth, some minute branches may pierce the alveolar plate and give sensation to the linguoalveolar process. (See Figs. 79, 80, 81, and 82.)

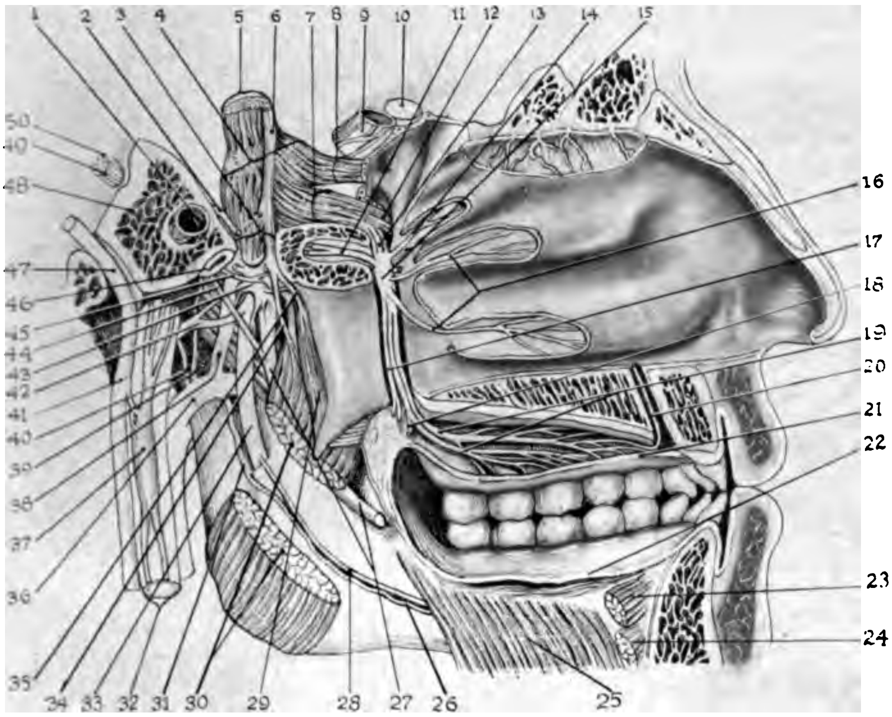


Fig. 77.—The otic and sphenopalatine ganglion. (Redrawn from Sobotta-McMurrich.)

1, Internal carotid artery; 2 and 3, mandibular nerve; 4, semilunar ganglion; 5, trigeminal nerve (portio-major); 6, portio-minor (motor); 7, maxillary nerve; 8, ophthalmic nerve; 9, internal carotid artery; 10, optic nerve; 11, nerve of pterygoid canal; 12, infraorbital nerve; 13, sphenopalatine nerve; 14, post-lateral nasal branch; 15, sphenopalatine ganglion; 16, posterior lateral nasal nerves; 17, posterior palatine nerve; 18, middle palatine nerve; 19, anterior palatine nerve; 20, nasopalatine nerve; 21, palatine mucous membrane; 22, oral mucous membrane; 23, genio-glossus; 24, geniohyoideus; 25, mylohyoideus; 26, mylohyoid branch of inferior alveolar artery; 27, lingual nerve; 28, mylohyoid nerve; 29, tensor veli palatini; 30, pterygoideus internum; 31, inferior alveolar artery; 32, internal carotid artery; 33, inferior alveolar nerve; 34, internal pterygoid nerve; 35, branch to tensor veli palatini; 36, internal maxillary artery; 37, superior cervical ganglion; 38, middle meningeal artery; 39, tympanic artery (anterior); 40, deep auricular artery; 41, nodular ganglion of vagus; 42, auriculotemporal nerve; 43, otic ganglion; 44, chorda tympani; 45, branch to tensor tympani; 46, tuba auditiva; 47, jugular ganglion of vagus; 48, temporal bone; 49, facial nerve— acoustic nerve; 50, great superior petrosal nerve.

In the previous discussion of the outer nerve loop, which is formed by the posterior, middle and anterior superior alveolar nerves, it was said that this nerve loop not only supplied the teeth on the corresponding side, but also the alveolar process and soft tissues buccally and labially. As the anterior palatine nerve passes downward through the pterygopalatine canal, small branches are given off which are called the posterior inferior nasal branches, and they enter the nasal cavity giving sensation to the posterior part of the middle and superior meatus and inferior turbinate bone.

The Middle Palatine Nerve

The middle palatine nerve, which is a branch of Meckel's ganglion, is much smaller than the anterior palatine branch. It passes downward through a small palatine canal, passing through the pyramidal process, which is located on the palate bone, and then divides into numerous branches, which pass in all directions, but mostly posteriorly, supplying the mucous membrane of the soft palate and palatine tonsil, part of the velum, uvula, and tonsil. (See Figs. 40, 60, 77, and 79.)

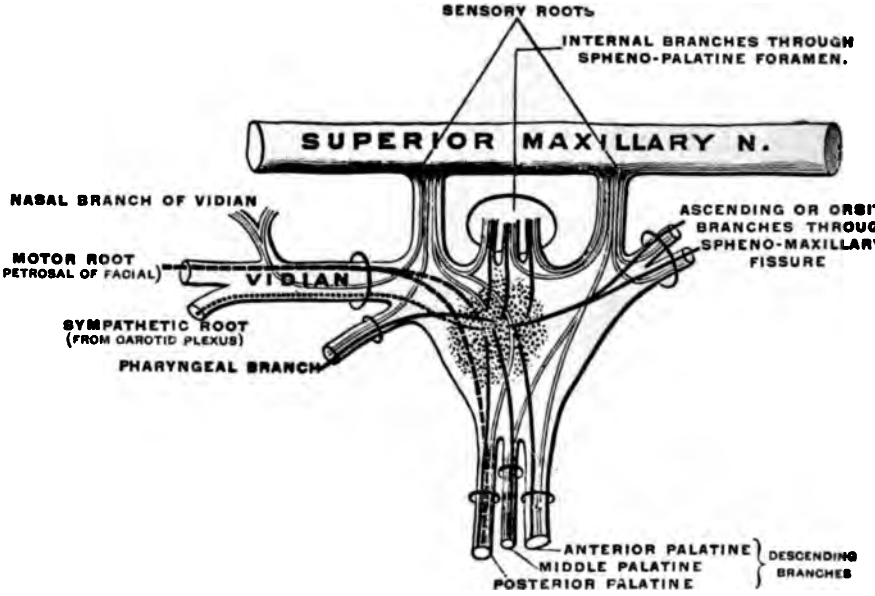

SENSORY ROOTS
INTERNAL BRANCHES THROUGH SPHENO-PALATINE FORAMEN.
SUPERIOR MAXILLARY N.
NASAL BRANCH OF VIDIAN
MOTOR ROOT (GREAT PETROSAL OF FACIAL)
VIDIAN
SYMPATHETIC ROOT (FROM CAROTID PLEXUS)
PHARYNGEAL BRANCH
ASCENDING OR ORBITAL BRANCHES THROUGH SPHENO-MAXILLARY FISSURE
ANTERIOR PALATINE
MIDDLE PALATINE
POSTERIOR PALATINE
DESCENDING BRANCHES

Fig. 78.—Diagram of constitution of sphenopalatine ganglion. (From Gerrish.)

The Posterior Palatine Nerve

The posterior palatine nerve is somewhat smaller than the anterior palatine branch, and passes downward for a short distance through a small palatine foramen and reaches the palatine velum, supplying the mucous membrane of the soft palate, uvula, tonsil, anterior and posterior pillars. In addition to sensitive fibers, this nerve contains motor fibers which supply the levator veli palatini with motor impulses. Piersol states that, in all probability, these motor fibers enter the posterior palatine nerve through the great superficial petrosal which originates from the facial or seventh cranial nerve. A deep nerve blocking injection will anesthetize the anterior, middle, and posterior palatine branches, which is one of the injections for tonsillectomy. The other injection for tonsillectomy is for the pharyngeal plexus which gives complete anesthesia of this region.

The following diagram should enable the reader to understand the branches given off of the descending group, which are the anterior, middle and posterior palatine branches, also the structures they supply:

- DESCENDING GROUP OR PALATINE BRANCHES FROM SPHENOPALATINE (MECKEL'S) GANGLION.
  - ANTERIOR PALATINE
    - Small nasal branches
      - To posterior inferior meatus.
      - To posterior inferior turbinate.
      - To posterior middle meatus.
    - Passes through posterior palatine foramen anteriorly on hard palate supplying gum tissue and periosteum, lingual to superior bicuspids and molars.
    - Interlaces with nasopalatine lingual to apex of superior cuspid tooth, thus forming inner or medial nerve loop.
  - MIDDLE PALATINE
    - To soft palate.
    - To uvula.
    - To tonsils and mucous membrane.
  - POSTERIOR PALATINE
    - To mucous membrane and soft palate.
    - To uvula.
    - To tonsil.
    - To anterior and posterior pillars.

Posterior Group of Branches from the Sphenopalatine Ganglion

The posterior group of branches consist of a number of nerves which pass posteriorly. Some of these branches pass into the mucous membrane and periosteum, situated in the extreme upper and posterior parts of the nasal cavity. (See Figs. 78 and 79.) One branch in this group is called the pharyngeal nerve. These branches give sensation to the mucous membrane and periosteum, as well as to some of the bone tissue located in the extreme upper posterior portion of the nasal cavity; also the sphenoidal sinus, all of the pharynx, etc.

The following diagram illustrates the branches and tissues which they supply:

- POSTERIOR GROUP OF BRANCHES FROM THE SPHENOPALATINE (MECKEL'S) GANGLION
  - Several branches to extreme superior posterior part of nasal cavity, septum of nose.
  - PHARYNGEAL BRANCH
    - To sphenoidal sinus.
    - To mucous membrane of nasopharynx and posterior nares.
    - Superior part of pharyngeal wall.
    - Medial part of eustachian tube.

Anterior, or Orbital, Group of Branches from Sphenopalatine Ganglion

The anterior, or orbital group is composed of a number of minute branches which are given off the sphenopalatine ganglion, their course being upward and anteriorly through the inferior orbital fissure, supplying sensation to the periosteum lining the orbit. Some branches pass into the posterior ethmoidal cells. Note the following diagram:

ANTERIOR OR ORBITAL GROUP OF BRANCHES FROM SPHENOPALATINE (MECKEL'S) GANGLION	Several small branches supply periosteum of orbit. Some branches to posterior ethmoidal cells.

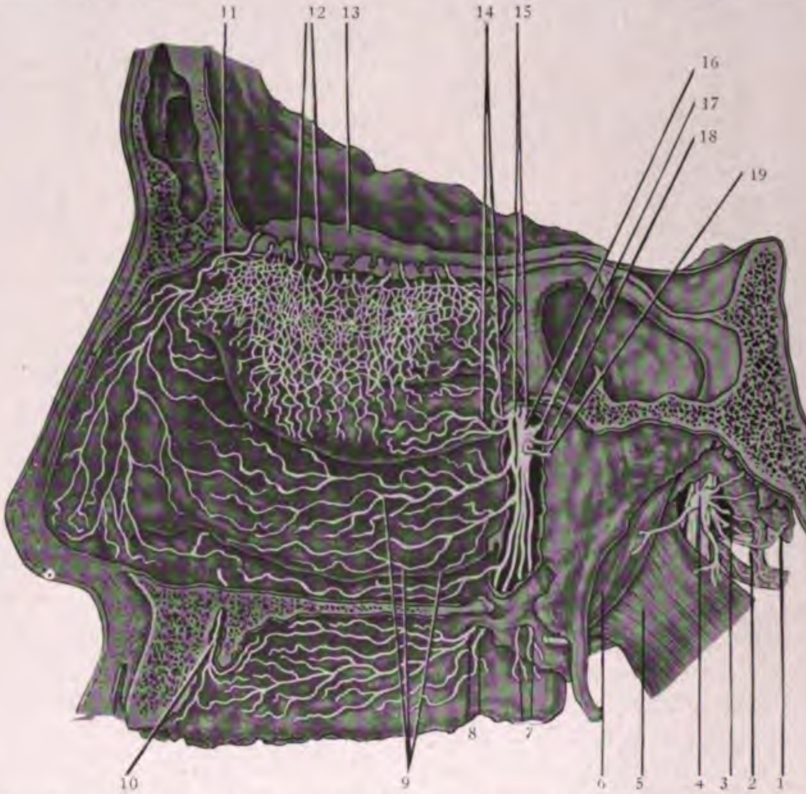


Fig. 79.—Illustrating the inner nerve loop formed by the anterior and nasopalatine nerves; also the nerve supply of the tissues of the nasal cavity. (Retouched from Deaver.)

1, Auriculo-temporal n.; 2, middle meningeal a.; 3, sympathetic root of otic gang.; 4, otic ganglion; 5, internal pterygoid m.; 6, tensor palati m.; 7, external palatine n.; 8, great palatine n.; 9, inferior nasal nerves; 10, nasopalatine n.; 11, anterior nasal branch of anterior ethmoidal; 12, olfactory n.; 13, olfactory tract; 14, superior nasal nerves; 15, sphenopalatine n.; 16, Meckel's ganglion; 17, vidian n.; 18, pharyngeal n.; 19, nasopalatine n.

Inner, or Medial, Nerve Loop.—The inner, or medial, nerve loop is formed by two large branches which arise from Meckel's ganglion (see Figs. 52, 60, and 80). The anterior part of the loop is formed by the nasopalatine nerve which belongs to the medial or nasal group of branches. The nasopalatine passes obliquely downward and forward, being embedded in the mucoperiosteum of the nasal septum. It courses its way anteriorly along a distinct groove, located on the surface of the perpendicular plate of the ethmoid and vomer bones. In its course along the nasal septum, it gives off small branches which supply this part with sensation. The nerve courses inward toward the median line and enters the foramina of Scarpa, which may coalesce with its fellow, thus opening into the incisive or anterior palatine foramen. This nerve passes

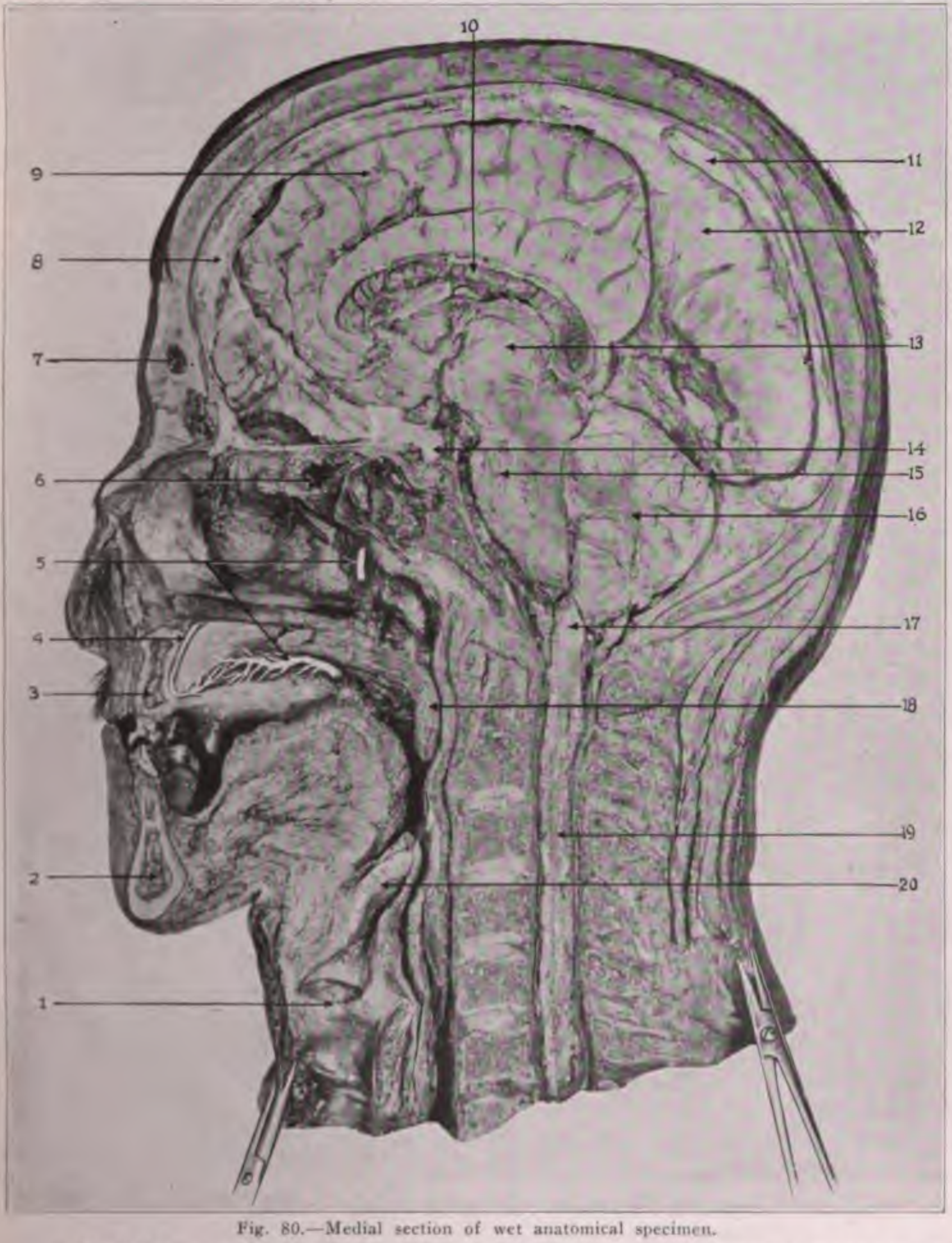


Fig. 80.—Medial section of wet anatomical specimen.

1, Vocal fold or cord of larynx; 2, mandible; 3, maxilla; 4, nasopalatine nerve; 5, anterior palatine nerve; 6, sphenoidal sinuses; 7, frontal sinuses; 8, falx cerebri; 9, medial surface of cerebral hemisphere; 10, corpus callosum; 11, superior sagittal sinus of dura; 12, falx cerebri; 13, thalamus; 14, hypophysis cerebri; 15, pons; 16, cerebellum; 17, medulla oblongata; 18, soft palate and uvula; 19, spinal cord; 20, epiglottis.

through the above-named foramen, making its exit upon the hard palate, at a point approximately 15 mm. lingual to the linguogingival margin of the two upper incisor teeth in the median line. (See Figs. 81 and 82.) Branches are given off posteriorly and anteriorly, which supply the mucous membrane and periosteum on the lingual side of the central, lateral, and cuspid teeth to a point lingual to the apex of the upper cuspid tooth, at which point an overlapping of the branches takes place with the anterior palatine branches. This is the connecting link between the two nerves which forms the inner nerve loop.

The anterior palatine nerve, which forms the posterior part of the inner or medial nerve loop is also a branch of Meckel's ganglion and belongs to the descending or palatine group or branches. It makes its exit upon the hard palate through the posterior palatine foramen, and in company with the greater palatine artery, it courses anteriorly in a distinct groove, which is located lingual to the apices of the lingual roots of the upper three molars and apices of the two upper bicuspids (see Figs. 77, 81, and 82). It interlaces with the nasopalatine at a point lingual to the apex of the upper cuspid tooth, thereby forming the connecting link which completes the inner or medial nerve loop, supplying the gum tissue and periosteum lingual to the above-named teeth and overlaps its fellow nerve in the median line. (See Fig. 81.)

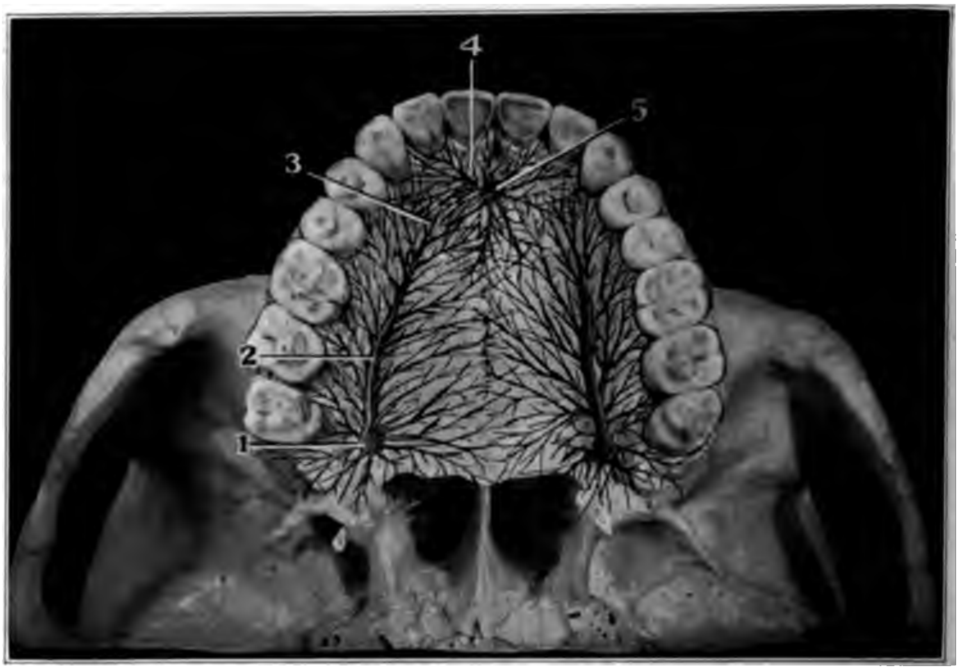


Fig. 81.—Drawing showing nerves of palate.

1, Anterior palatine nerve at the posterior palatine foramen; 2, anterior palatine nerve; 3, anastomosis of the anterior palatine and nasopalatine nerves; 4, nasopalatine nerve; 5, nasopalatine nerve at the anterior palatine foramen.

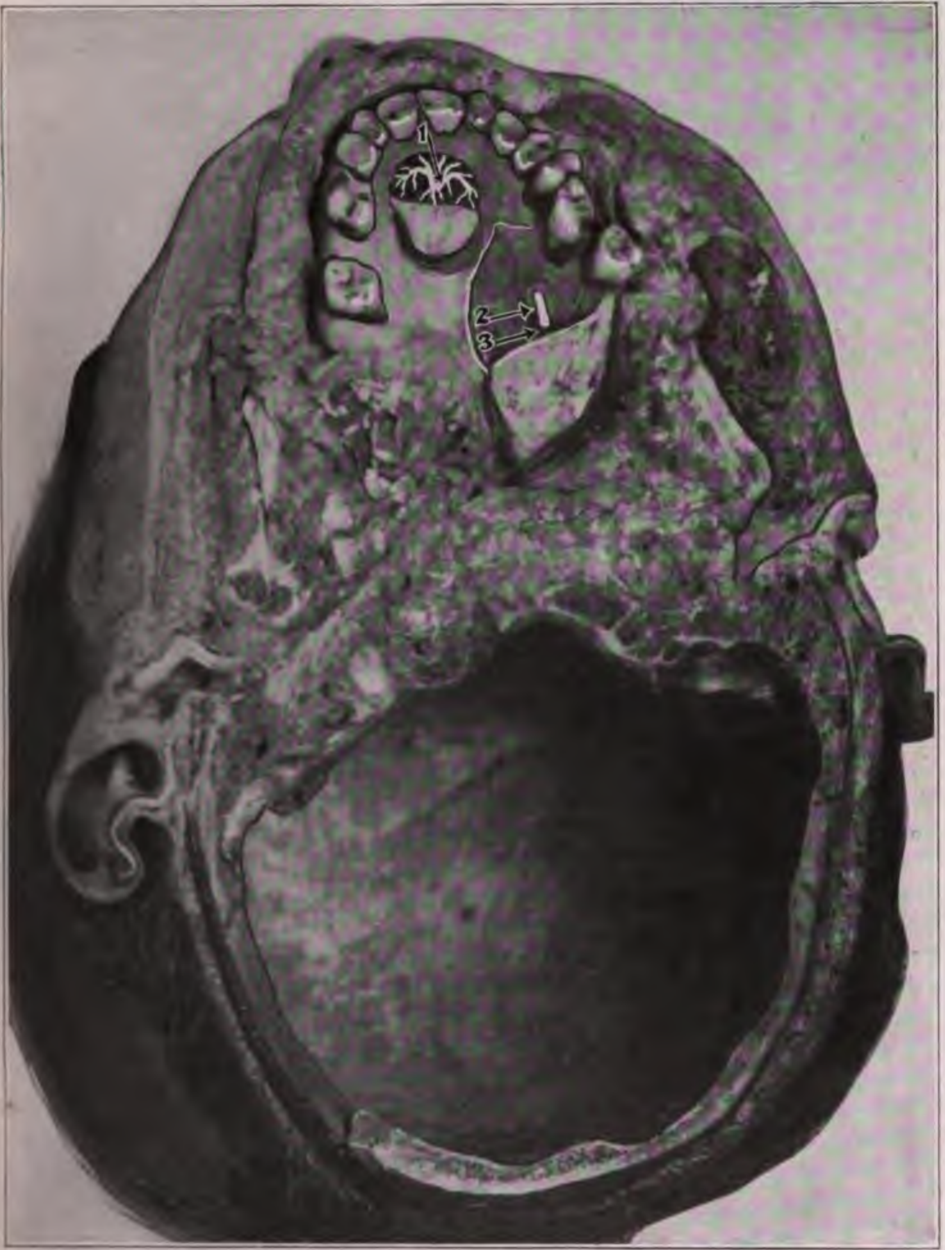


Fig. 82.—Wet anatomical specimen showing the following structures:

1, Nasopalatine nerves at anterior palatine foramen exposed by removal of flap; 2, anterior palatine nerve at the posterior palatine foramen exposed by removal of flap; 3, posterior palatine foramen.

Some short fibers may ramify the surface of the lingual alveolar plate for a short distance, thus giving the bone at this point some sensation, but it has been found that it is seldom necessary to block either branch forming the inner nerve loop, unless the operation involves the periosteum, gum tissue, and mucous membrane situated on the lingual side of the above-named teeth. The inner nerve loop, or a part of it, should never be blocked unless the nature of the operation demands it, for the reason that the operator is taking his valuable time to do the blocking, as well as wasting the anesthetizing solution, and is also making injections which are not necessary.

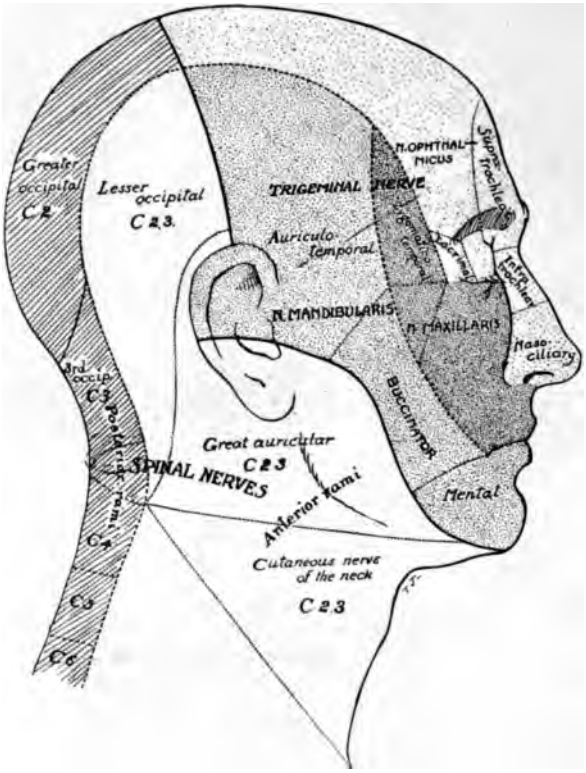


Fig. 83.—Cutaneous nerve areas of the head and neck. (From "Manual of Surgical Anatomy," prepared by Surgeon-General's Office, U. S. A.)

The operator should remember it is not necessary to block at this point unless the gum tissue, mucous membrane, and periosteum are to be involved during the operation, as for deep scaling, the treatment of pyorrhea alveolaris, extraction of teeth, in which the lingual beaks of the forceps would cause pain, application of cervical clamp or curettement of alveolar process composing the lingual plate, etc. For operations such as cavity preparation, shaping the crowns of teeth for abutments, pulp removal, which do not involve the lingual tissue, it is folly to block the inner nerve loop or a portion of it, for the reason that the blocking of the outer nerve loop or as much of it as is needed, depending on the location, is all that is necessary.

The reader should compare the anatomy and structures supplied by the inner or medial loop with the outer or external nerve loop and obtain a clear understanding of these two nerve loops which will be of value to him in the execution of his technic for block anesthesia.

Nervus Mandibularis

Synonyms.—*Mandibular Nerve or Third Division of Fifth Cranial Nerve.*—The mandibular or third division of the fifth cranial nerve is the largest of the three divisions and is a mixed nerve, containing both motor and sensory fibers. The origin of sensory fibers of the fifth nerve has already been discussed. The motor fibers arise from the pons and near the floor of the fourth ventricle. (See Figs. 45 and 60.) The sensory and motor roots which compose the fifth nerve pass together anteriorly in the middle fossa of the skull just below the dura mater to the foramen ovale. The motor root in its course is concealed by the large sensory root. (See Figs. 40, 41, 42, 60, and 85.) The sensory fibers connecting with the Gasserian ganglion and the motor fibers, which are distinct and separate, blend with each other to form a single nerve trunk which is the largest division of the three divisions comprising the fifth cranial nerve.

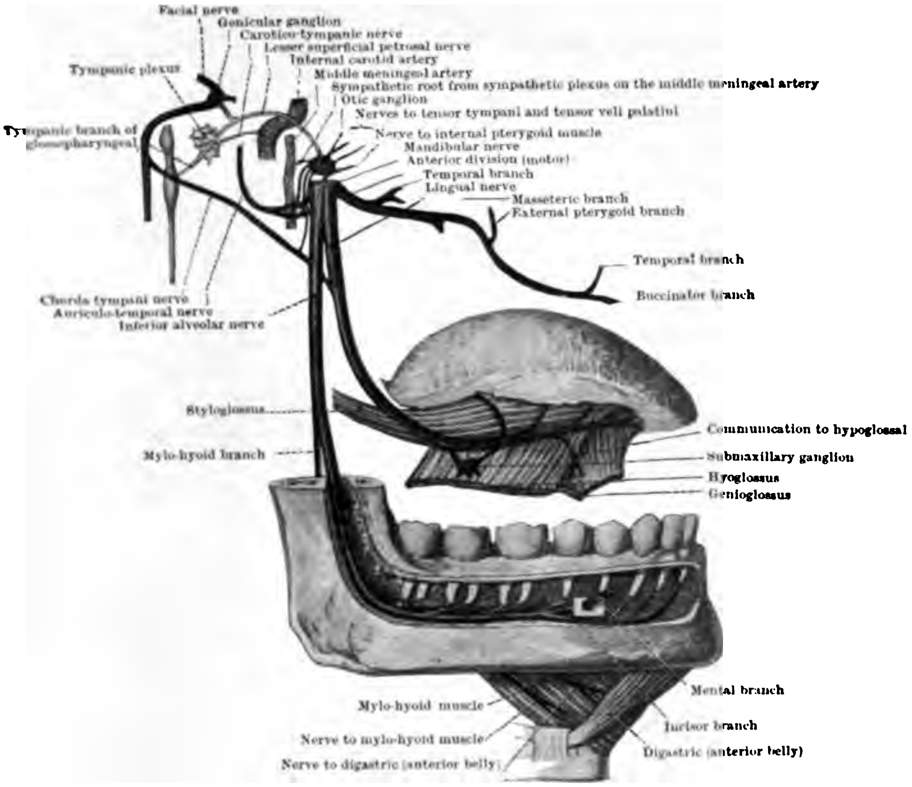


Fig. 84.—The mandibular and lingual nerves. (From Cunningham.)

(See Figs. 40 and 60.) The sensory and motor branches enter the intratemporal fossa through the foramen ovale, and they immediately combine, thus forming a single nerve trunk which is surrounded by a common sheath. When the union of the motor and sensory fibers takes place, thereby forming a common nerve trunk, it is situated internal to the external pterygoid muscle, and is external to the tensor palati muscle a distance approximately 1 cm. from the foramen ovale. This nerve trunk ends by separating into two divisions which are known as the anterior and posterior. This part of the third division is concealed by the ramus of the mandible, by the external pterygoid, temporal and masseter muscles, and is situated deeply beneath the zygomatic arch. The branches arising from the third or mandibular division of the fifth nerve are also divided into, *first*, those branches which

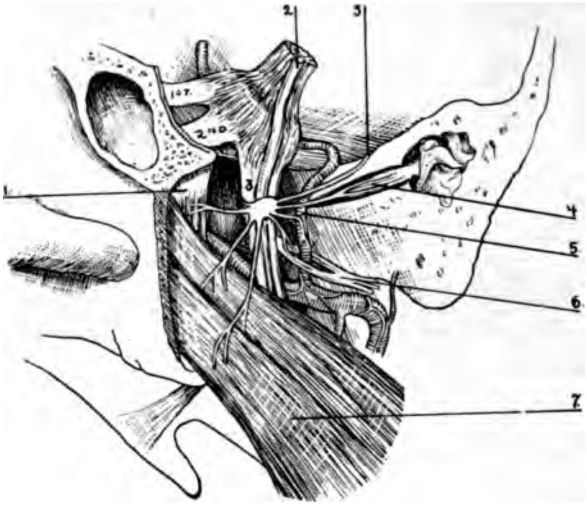


Fig. 85.—1, Tensor veli palatini; 2, fifth nerve; 3, lesser superior petrosal nerve; 4, tens tympani; 5, middle meningeal artery; 6, auriculotemporal nerve; 7, internal pterygoid. (Redrawn from Gray.)

are given off the undivided nerve and, *second*, those branches given off the terminal division.

Branches Which Are Given off the Undivided Mandibular Nerve Just Exterior to the Foramen Ovale

The first branch which is given off the undivided nerve is a small one, called the nervus spinosus, or recurrent nerve. It is given off just outside the foramen ovale, and is a slender branch which enters the cranium with the middle meningeal artery and supplies the dura mater. This artery and nerve gain entrance to the cranial cavity through the foramen spinosum.

The next branch given off is a motor one which passes to the internal pterygoid muscle for the purpose of supplying the same with motor impulses. This nerve passes from its origin along the superior part and posterior border of this muscle. The nerve is connected with the otic ganglion which will be taken up later for consideration. (See Figs. 60, 84, and 86.) Note the following diagram:

BRANCHES GIVEN OFF UNDIVIDED MANDIBULAR OR THIRD DIVISION OF FIFTH NERVE	Nervus spinosus or recurrent (sensory) through foramen spinosus to dura mater. Internal pterygoid (motor) to internal pterygoid muscle, connects with otic ganglion.

The terminal division of the mandibular nerve is divided into an anterior or upper division and a posterior or lower division. Each division gives off a number of branches.

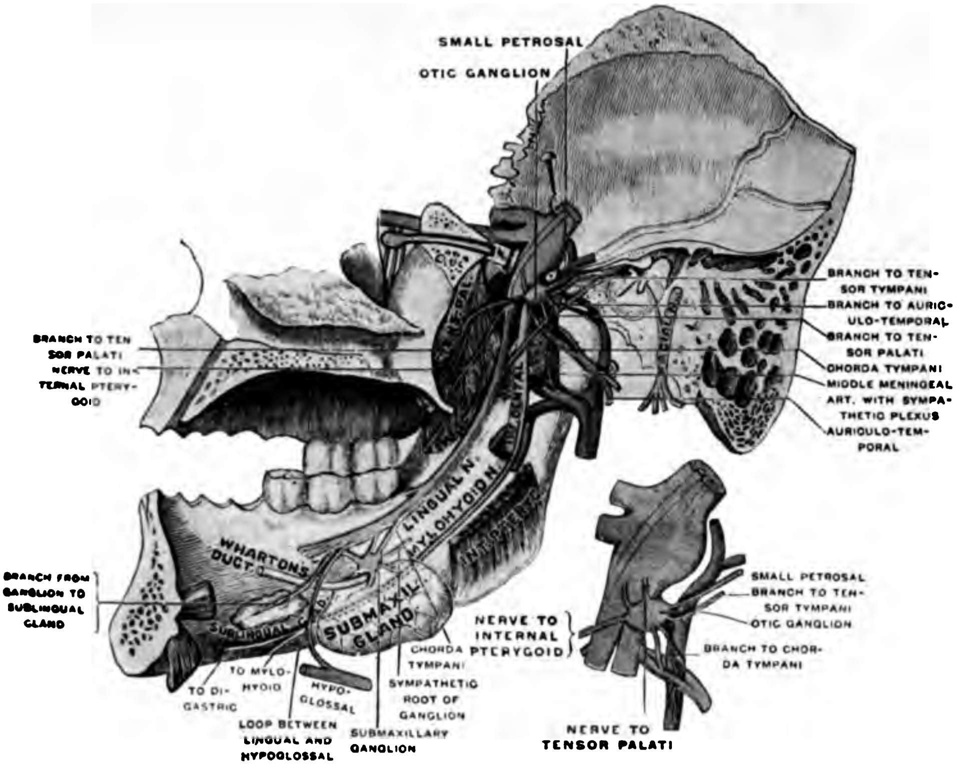


Fig. 86.—Mandibular division of trifacial nerve, seen from the middle line. The small figure is an enlarged view of the otic ganglion. (From Testut.)

Branches Which Arise from the Anterior or Upper Division of Mandibular Nerve

The first branch which is given off is called the masticator nerve. It passes anteriorly and downward anterior to the external pterygoid muscle, and divides into several branches, which are the masseteric, deep temporal, external pterygoid and long buccal branches. (See Figs. 60 and 96.)

The masseteric nerve passes posterior to the temporal muscle and superior to the external pterygoid muscle, and thence through the sigmoid

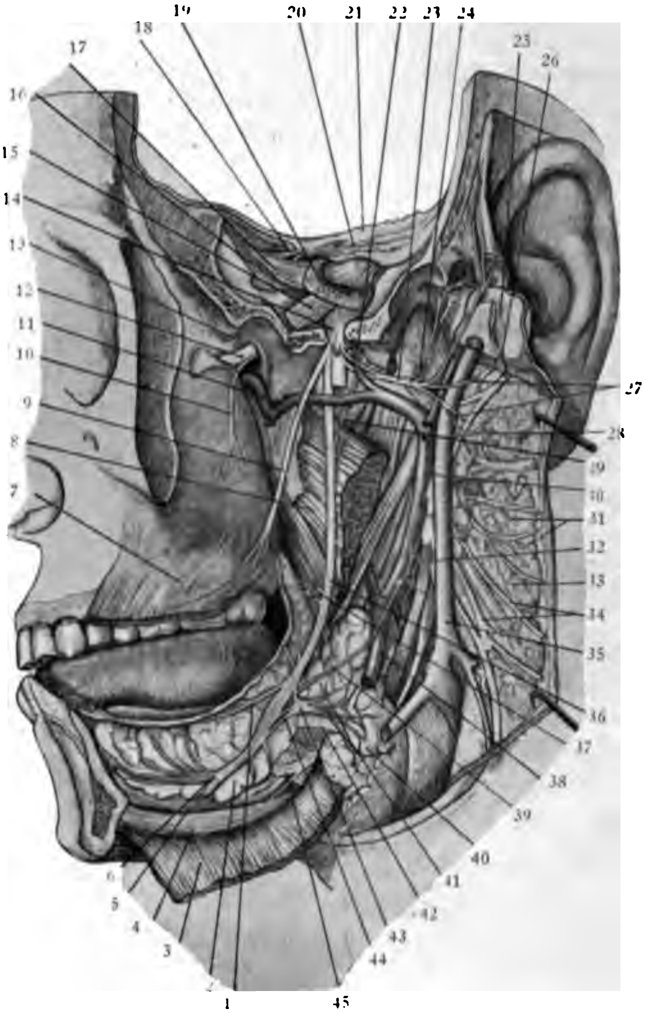


Fig. 87. The mandibular nerve or third division of the fifth cranial nerve. Its motor branches, also the inferior dental, have been incised short, close to the base of the skull. (Retouched from Toldt.)

1, Offsets to mucous membrane of floor of oral cavity; 2, sublingual gland; 3, mylohyoid muscle (turned downwards); 4, geniohyoid muscle; 5, genioglossus or geniohyoglossus muscle; 6, sublingual nerve; 7, buccinator muscle; 8, internal pterygoid muscle; 9, buccal nerve; 10, superior dental or alveolar nerve; 11, internal maxillary artery; 12, infraorbital nerve; 13, pterygomaxillary fissure; 14, inferior maxillary nerve; 15, superior maxillary nerve; 16, sphenoidal or superior orbital fissure; 17, ophthalmic nerve; 18, fourth cranial, pathetic, or trochlear nerve; 19, **ganglion of fifth nerve, or Gasserian ganglion**; 20, recurrent or meningeal branch of ophthalmic nerve; 21, tentorium cerebelli, or tent; 22, middle meningeal artery with recurrent or middle meningeal branch of inferior maxillary nerve; 23, auriculotemporal nerve; 24, nerves of external auditory meatus; 25, cartilage of external auditory meatus; 26, branches of facial nerve; 27, communicating branch between auriculotemporal nerve and facial nerve; 28, parotid branch; 29, chorda tympani nerve; 30, external carotid artery; 31, parotid branches of facial nerve; 32, external carotid plexus; 33, parotid gland; 34, branches of facial nerve; 35, temporomaxillary vein; 36, lingual nerve; 37, branches to isthmus of fauces; 38, facial artery; 39, sympathetic root of submaxillary ganglion; 40, submaxillary gland; 41, submaxillary branches; 42, submaxillary duct, or duct of Wharton; 43, submaxillary or lingual ganglion; 44, communicating branches to lingual nerve; 45, hypoglossal nerve.

notch, and enters the masseter muscle. (See Figs. 60, 84 and 88.) This nerve, in addition to its motor fibers, contains some sensory fibers which supply the temporomaxillary articulation.

The deep temporal nerve, with the anterior posterior branches, which are located anterior and posterior to the temporal muscle, passes horizontally between the temporal bone and muscle, and then ascends over the wing of the sphenoid bone and supplies the temporal muscle with motor impulses. (See Figs. 60 and 88.)

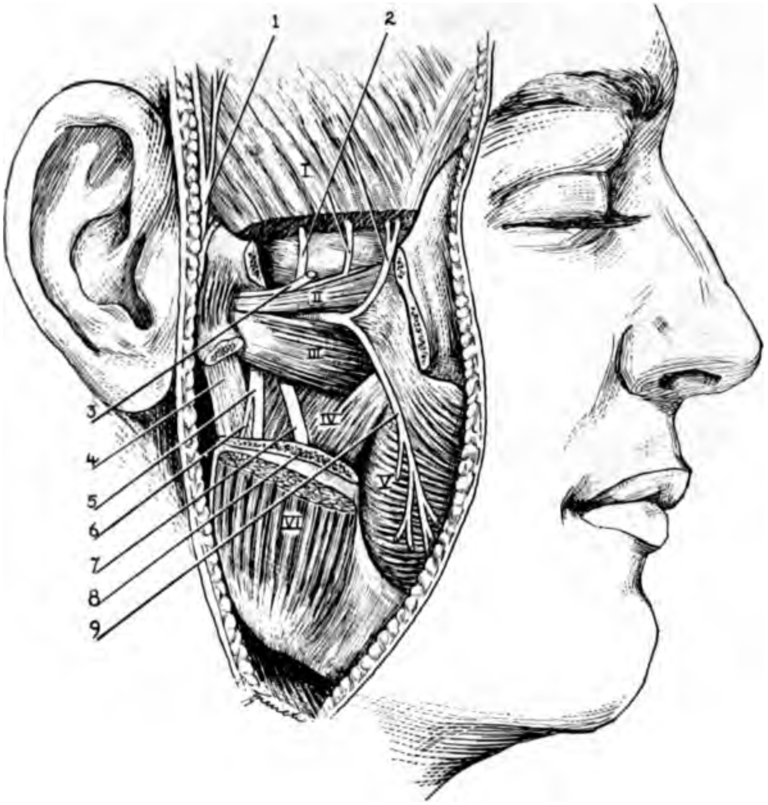


Fig. 88.

1, Auriculotemporal nerve; 2, deep temporal nerve; 3, masseteric nerve; 4, sphenomandibular ligament; 5, inferior alveolar nerve; 6, mylohyoid nerve; 7, lingual nerve; 8, ramus of mandible (cut); 9, buccinator nerve. I, Tendon of temporalis muscle; II, pterygoideus muscle; III, externus muscle; IV, pterygoideus internis muscle; V, buccinator muscle; VI, masseter muscle. (Modified from Gray.)

The external pterygoid nerve is the next branch given off, and Sabotta and McMurrich state that it may not arise from the main trunk, but may arise from the buccinator nerve in which it may be enclosed. It passes directly to the external pterygoid muscle supplying it with motor impulses. (See Figs. 60 and 84.)

The Buccinator or Long Buccal Nerve is the next branch given off under this division. This branch passes between the external and internal heads of the external pterygoid muscle. This nerve is not a mixed nerve, but is purely sensory, and it is the only branch which is given off from the anterior or upper division that is purely sensory, all the rest being motor and supplying the muscles of mastication. (See Diagram, page 130.)

After passing between the heads of the external pterygoid muscle, it passes obliquely forward and is situated between the buccinator and masseter muscles. It then passes downward and laterally, piercing the posterior surface of the buccinator muscle at several places, and divides into numerous branches which supply the buccal mucous membrane inside the cheek and mouth, and the skin on the cheek. In 75 per cent of the cases, the buccal gum tissue, the mucous membrane between the cheek and gum tissue and periosteum, buccal to the lower second and third molars, are supplied with sensation by branches from this nerve. In 5 per cent of the cases the long buccal nerve sends branches to the buccal side of the lower first molar. (See Figs. 60, 87, 88, 89, 93, and 125.)

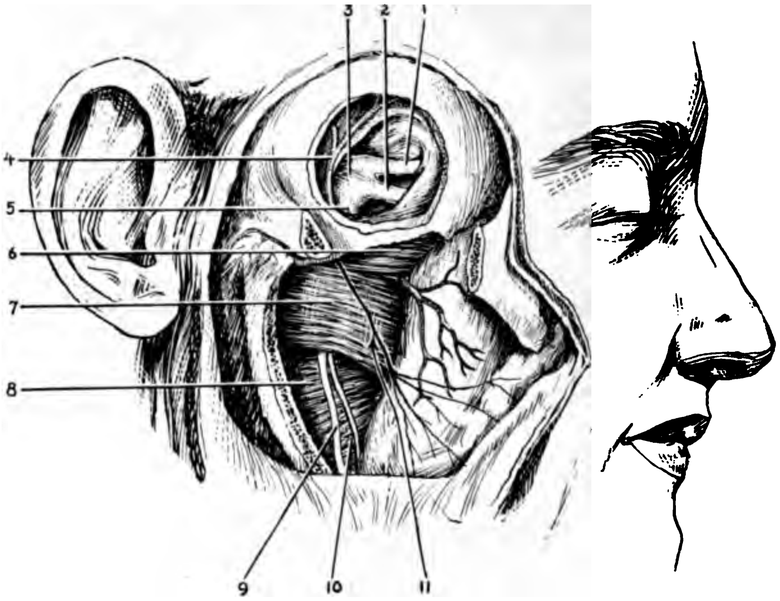


Fig. 89.

1, Ophthalmic division; 2, superior maxillary division; 3, Gasserian ganglion; 4, middle meningeal artery; 5, mandibular nerve; 6, upper head external pterygoid muscle; 7, lower head external pterygoid muscle; 8, internal pterygoid muscle; 9, inferior dental nerve; 10, lingual nerve; 11, long buccal nerve. (Modified and redrawn from Davis.)

In many individuals the branches of the long buccal nerve do not extend so far downward and anteriorly as they do in others. It is the author's experience that in 25 per cent of the cases it is not necessary to make the long buccal injection, either buccal to the lower second and third molars, or inferioposteriorly to the opening of Stenson's duct.

In those cases in which the buccal gum tissue, periosteum, and mucous fold are supplied by the buccinator nerve, numerous small branches are given off, which ramify the tissue, giving sensation to these parts in addition to the nerve supply from the inferior dental.

Many operators are under the impression that the long buccal nerve is very small and disregard it. Consequently they inflict pain upon their patients in attempting to extract the lower second or third molar, or in performing operative work upon these teeth if the operation involves the buccal tissue.

In addition to the long buccal branches which supply the buccal fold, gum tissue, and periosteum buccal to the lower second and third molar in 75 per cent of the cases, it also supplies the buccal fold, gum tissue, and periosteum in the region of the tuberosity. The posterior superior dental injection not only blocks the posterior superior dental nerve, which supplies the tuberosity, the upper second and third molars and buccal structures, but it also anesthetizes the small buccal nerve branches which are located in this immediate region. This eliminates the necessity of making a separate injection for the long buccal nerve, as

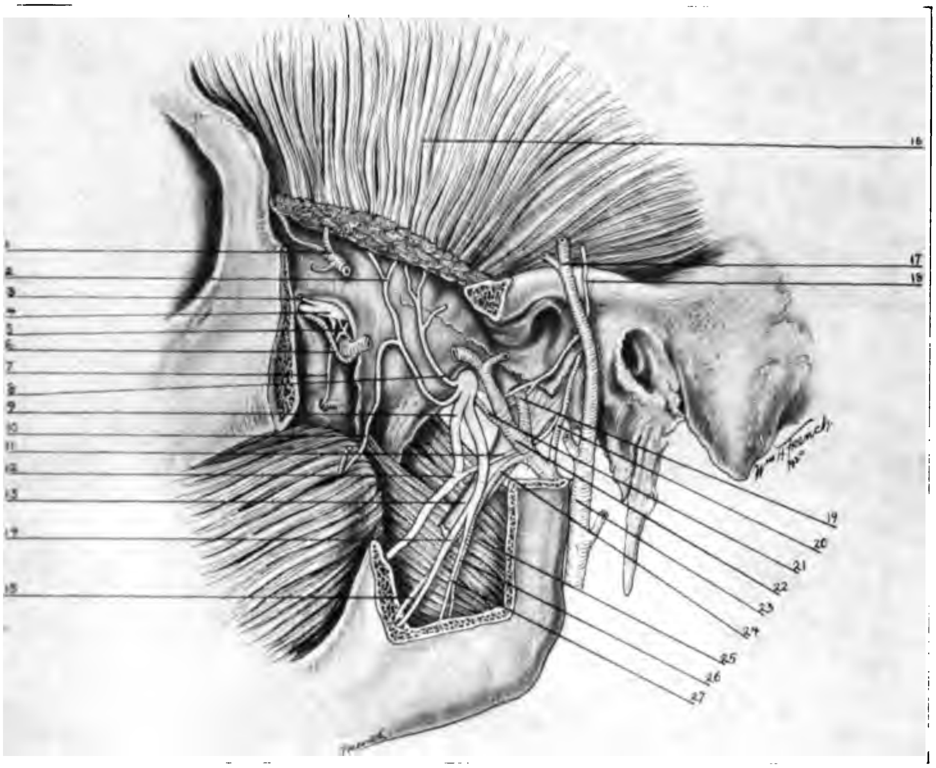


Fig. 90.—Inferior maxillary nerve. (Redrawn from Deaver.)

1, Anterior deep temporal artery; 2, anterior temporal nerve; 3. orbital nerve; 4, superior maxillary nerve; 5, Meckel's ganglion; 6, infraorbital artery; 7, posterior superior dental nerve; 8, posterior temporal nerve; 9, lingual nerve; 10, long buccal nerve; 11, chorda tympani; 12, lingual nerve; 13, internal lateral ligament; 14, inferior dental nerve; 15, inferior dental artery; 16, temporal muscle; 17, superficial temporal artery; 18, auriculotemporal nerve; 19, middle meningeal artery; 20, tympanic artery; 21, small meningeal artery; 22, internal maxillary artery; 23, external carotid; 24, inferior dental artery; 25, internal pterygoid muscle; 26, mylohyoid artery; 27, mylohyoid nerve.

is often necessary for operating upon the lower second and third molars if the buccal tissue is involved.

The accompanying diagram contains the nerves given off the anterior or upper division of the mandibular nerve.

BRANCHES GIVEN OFF ANTERIOR OR UPPER DIVISION OF MANDIBULAR NERVE (ALL MOTOR BRANCHES EXCEPT LONG BUCCAL BRANCH)

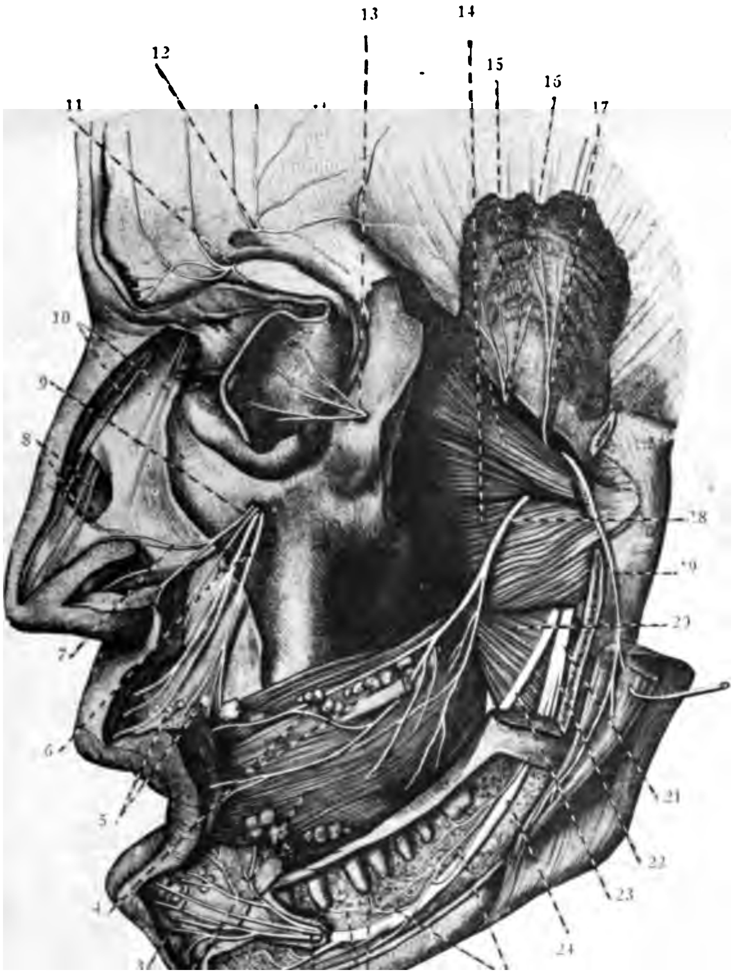
- (MOTOR) Posterior deep temporal to temporal muscle.
- (MOTOR) Anterior deep temporal to temporal muscle.
- (MOTOR) Masseteric to masseter muscle.
- (MOTOR) External pterygoid to external pterygoid muscle.
- (SENSORY) Long buccal or buccinator to
  - Mucous membrane lining cheek and mucous fold.
  - Gum tissue, periosteum, mucous membrane, buccal and distal, to second and third lower molars in 75 per cent of cases. In 5 per cent of cases the buccal surface of the lower first molar.
  - Skin on surface of cheek.
  - Communicates by buccal plexus with seventh or facial nerve.

Branches Which Are Given off the Posterior, or Lower, Division of the Mandibular Nerve

This large posterior or lower trunk passes directly downward for a short distance, being situated beneath the external pterygoid muscle, and it divides into three branches which are the auriculotemporal, lingual and inferior dental branches. (See Figs. 60, 90, 94, 95, and 104.)

The Auriculotemporal Nerve

The auriculotemporal nerve is a branch of the mandibular and is usually given off by two roots and situated beneath the external pterygoid muscle. (See Fig. 88.) The roots of this nerve are sensory and connect with the otic ganglion, and indirectly connect with the ninth cranial or glossopharyngeal nerve. This nerve is closely associated with the middle meningeal artery, which is situated beneath the external pterygoid muscle. The direction of this nerve is first posteriorly between the sphenomandibular ligament and the condyle of the inferior maxillary bone. From this point, it passes upward anterior to the external auditory canal and passes between the internal and external carotid, and is almost covered by the posterior border of the parotid gland. It passes midway between the tragus of the external ear and the posterior root of the zygomatic arch; it crosses the zygoma in close re-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superior and inferior, supplying the skin near the tragus, part of the helix and upper part of the auricle, and a branch which supplies the parotid gland. There are other branches which communicate with the inferior dental and otic ganglion; also a branch to the temporomandibular joint. The anterior and posterior superficial temporal branches pass posterior to the superficial temporal artery, supplying the skin and superficial fascia in the region of the

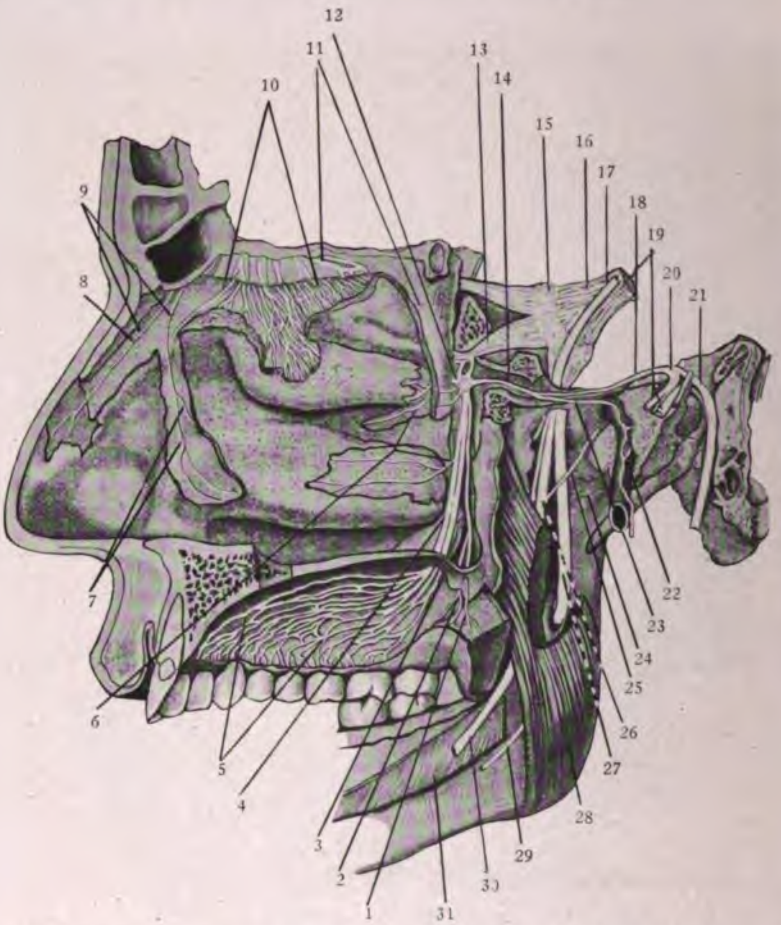


Fig. 92.—Showing the nerve supply of the mucous membrane of the nasal cavity, also nerve supply of the hard palate and in addition the lingual and inferior dental branches. (Retouched from Toldt.)

1, Small or posterior palatine plate; 2, external palatine nerve; 3, orifice of posterior palatine canal; 4, large or anterior palatine nerve; 5, ramification of large or anterior palatine nerve on lower surface of hard palate; 6, upper nasal branches of Meckel's ganglion and inferior nasal branches of large or anterior palatine nerve (outer set); 7, external branches of nasal nerve; 8, anterior or superficial branch of nasal nerve; 9, terminal branches of nasal nerve; 10, olfactory nerves (outer group); 11, mucous membrane of septum of nose with olfactory nerves (inner group); 12, sphenopalatine ganglion; 13, superior maxillary nerve; 14, vidian nerve; 15, ganglion of fifth nerve, or Gasserian ganglion; 16, large or sensory root; 17, small or motor root of fifth cranial, trifacial, or trigeminal nerve; 18, great superficial petrosal nerve; 19, facial and auditory nerves; 20, geniculate ganglion; 21, facial nerve; 22, internal carotid plexus; 23, great deep petrosal nerve; 24, external pterygoid muscle; 25, chorda tympani nerve; 26, lingual nerve; 27, inferior dental nerve; 28, internal pterygoid muscle; 29, nerve to mylohyoid muscle; 30, lingual nerve; 31, mylohyoid muscle (cut short).

temporal muscle, communicating with the supraorbital, zygomaticotemporal and occipital nerves. (See Figs. 60, 77, 84, 94, 95, and 96.)

The mandibular nerve divides into two terminal branches, which are the lingual and the inferior dental. (See Figs. 60, 95, and 96.)

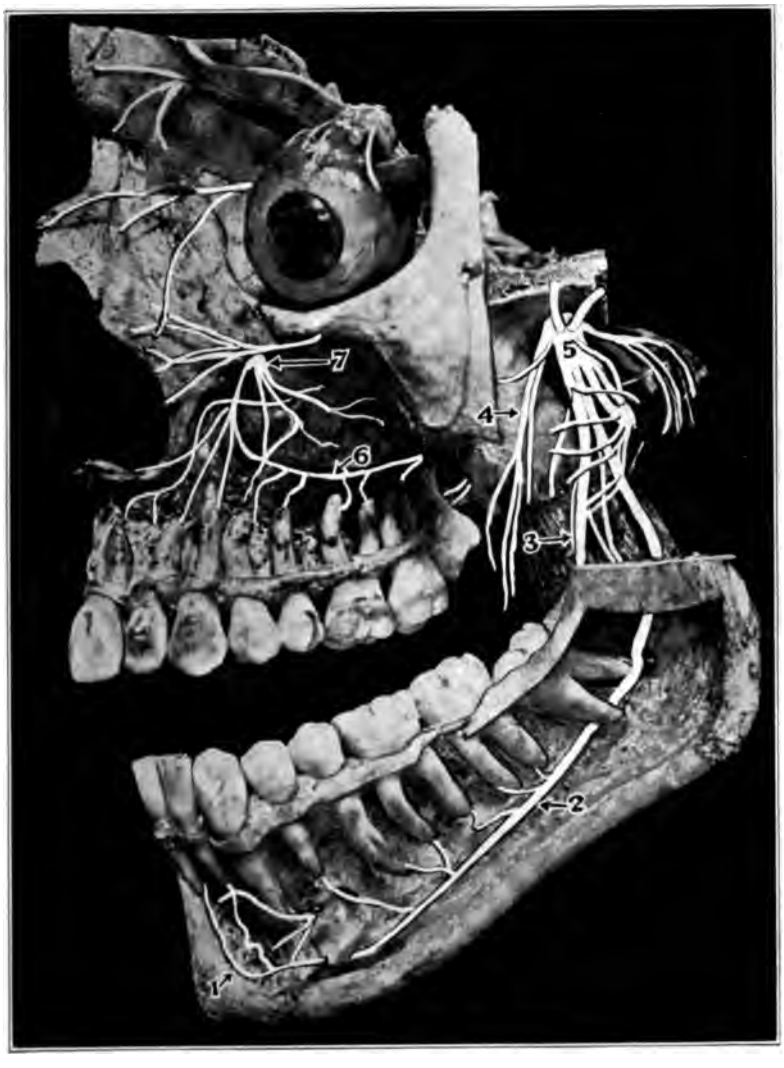


Fig. 93.– Trigeminal or fifth cranial nerve. (Modified from Quain.)

1, Incisive nerve; 2, inferior dental nerve; 3, lingual nerve; 4, long buccal; 5, mandibular; 6, anterior palatine; 7, peripheral endings of the infraorbital nerve.

Lingual Nerve.—The lingual nerve is purely sensory, and is the smaller of the two terminal divisions.

The course of this nerve is downward, laterally, and slightly anteriorly until it reaches a level of 1 cm. above the occlusal plane of the lower teeth. At

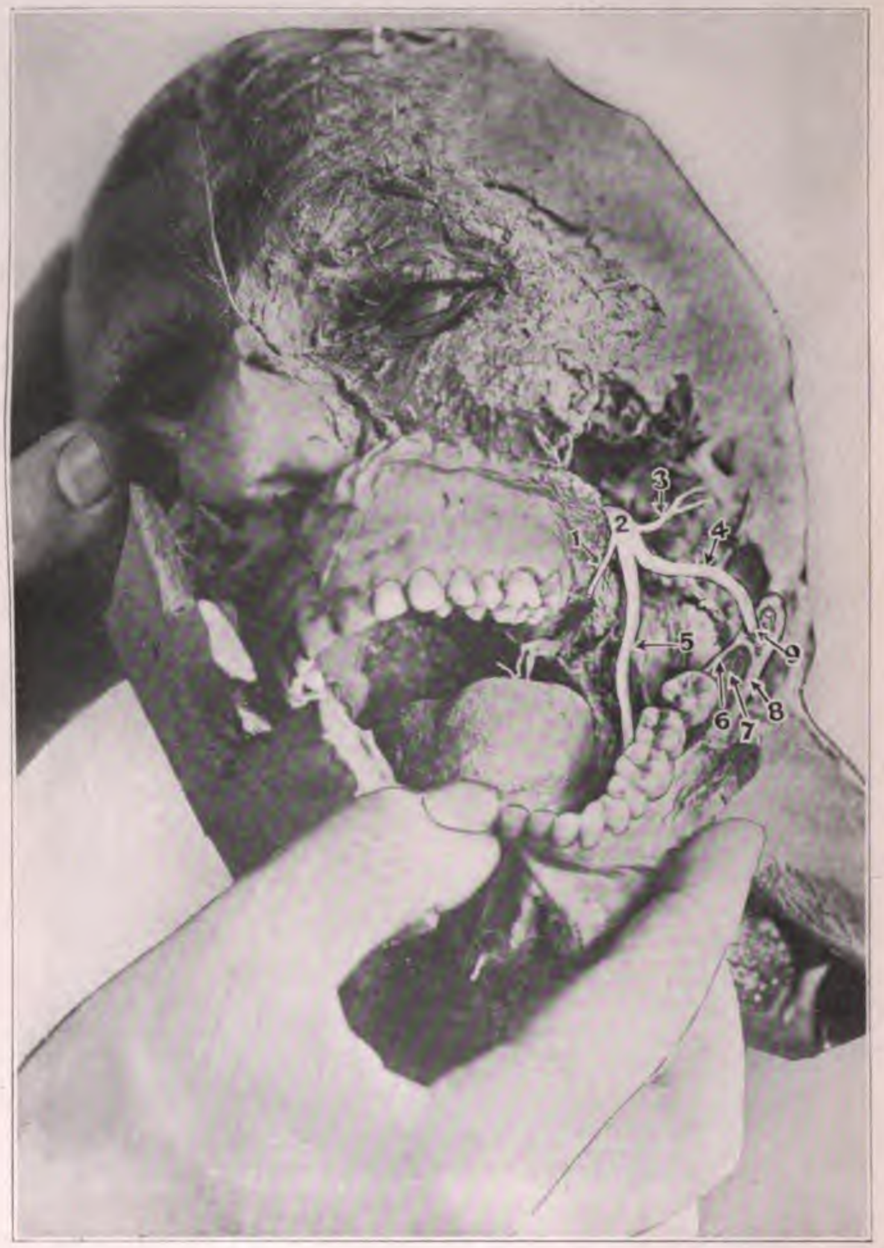


Fig. 94.—Wet anatomical dissected specimen showing the following structures:

1, Long buccal nerve; 2, mandibular nerve; 3, auriculotemporal nerve; 4, inferior dental nerve; 5, lingual nerve; 6, internal oblique line; 7, retromolar triangle; 8, external oblique line; 9, inferior dental foramen.

this level it is situated 1 cm. anterior to the inferior dental nerve. It is located approximately 1 cm. from the surface of the mucous membrane, at a point where it is blocked, or approximately midway between the surface of this membrane and the inferior dental nerve, the latter being located approximately 2 cm. from the surface. (See Fig. 105.) As the lingual nerve passes downward, laterally and anteriorly, it is situated from 5 to 7 mm. lingual to the internal oblique line of the ascending ramus, and is surrounded by loose connective tissue. (See Fig. 105.) It enters this region through the pterygomaxillary region; that is, between the ascending ramus of the mandible and the internal pterygoid muscle. (See Figs. 88, 90, 91, 92, 98, and 104.) After it leaves the region of 1 cm. above the occlusal plane of the lower teeth, it passes anteriorly and downward and enters the submaxillary region, being situated near the lingual alveolar plate

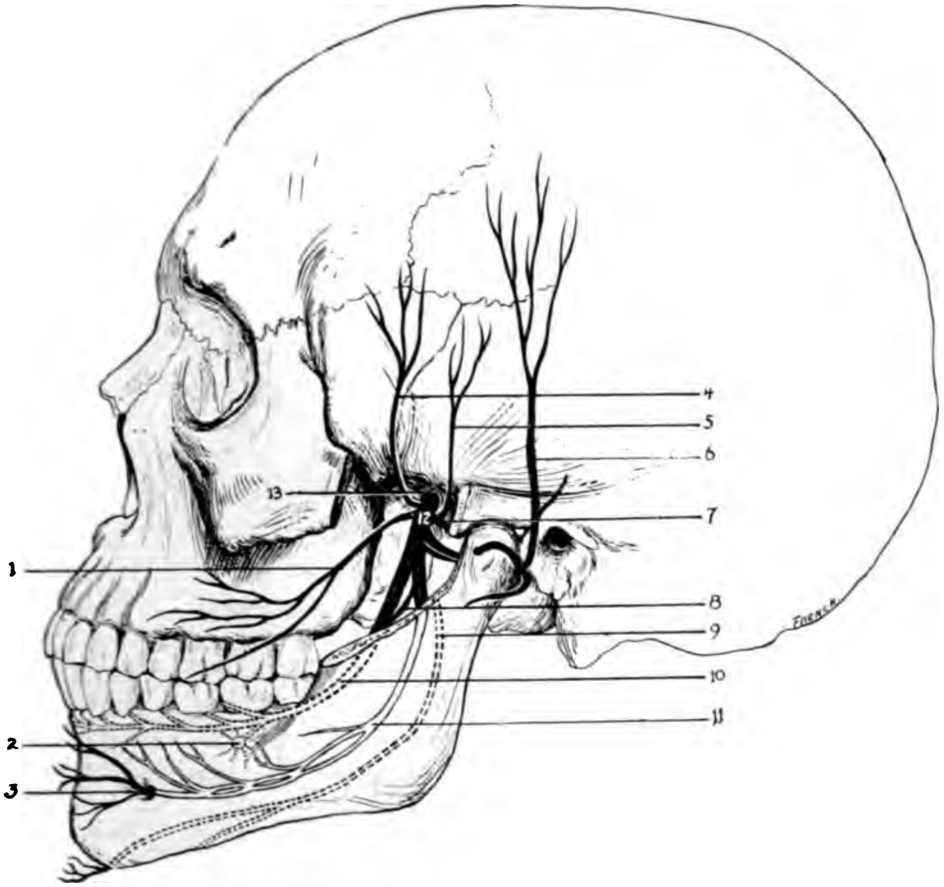


Fig. 95.—Illustrating the mandibular or third division of the fifth cranial nerve and its principal branches.

1, Long buccal nerve; 2, submaxillary ganglion; 3, mental nerve; 4, anterior temporal nerve; 5, posterior temporal nerve; 6, auricular temporal nerve; 7, nerve to masseter; 8, chorda tympani; 9, mylohyoid nerve; 10, lingual nerve; 11, inferior dental nerve; 12, mandibular division; 13, foramen ovale.

covering the roots of the lower third molar. (See Figs. 86, 92, 94, 95, 98, 99, and 110.)

In case the lower third molar is impacted or is lingually inclined, thereby causing a protrusion of the lingual alveolar plate, the lingual nerve may be in actual contact with the lingual plate. Care should be taken while extracting, curetting the socket, or chiseling away the alveolar process for the removal of a tooth of this character, not to cause injury to this nerve. The lingual nerve now passes medial to the lingual alveolar plate, gradually sweeping across the floor of the mouth and dividing into many branches which supply the anterior two-thirds of the tongue, mucous membrane, the floor of the mouth, lingual gum tissue and periosteum lingual to the lower molars, bicuspids, cuspid and incisor teeth, communicating with and overlapping its fellow nerve in the region of the median line. (See Figs. 84, 87, 97, 99, 100, and 101.) When this nerve is given off the third division, it is at least 3 mm. in diameter and con-

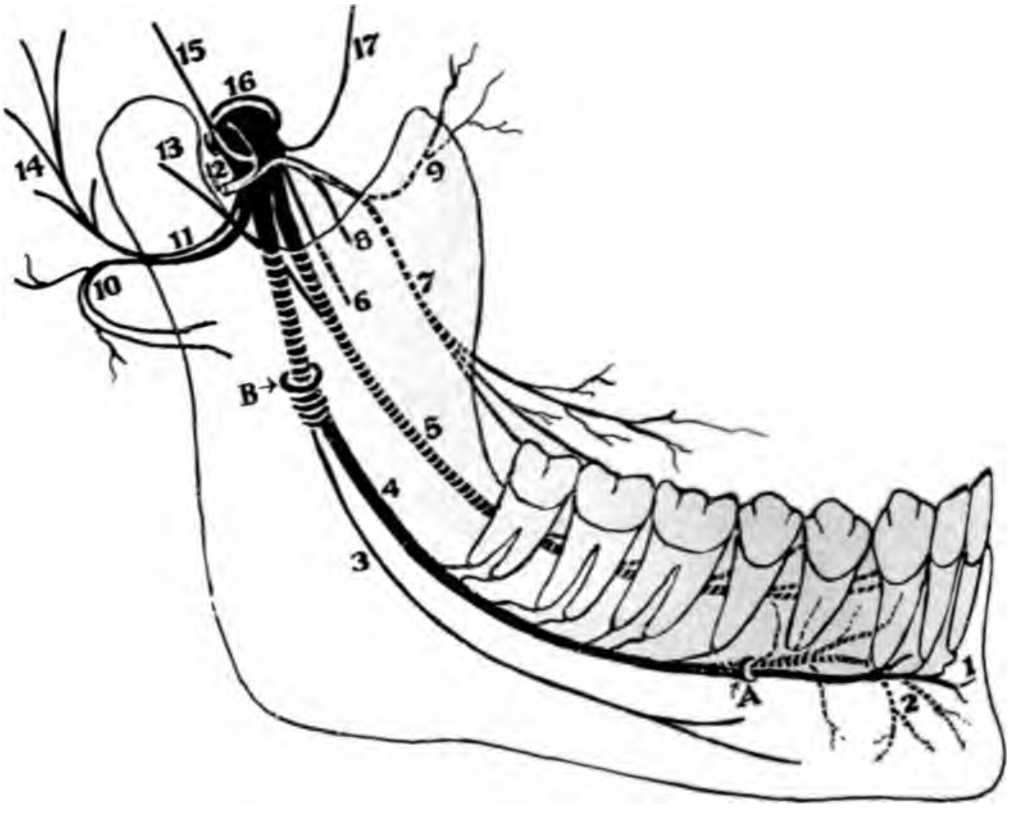


Fig. [illegible].—Illustrating the mandibular or third division of the fifth cranial nerve and its principal branches.

1, Incisive nerves; 2, mental nerves; A, mental foramen; 3, mylohyoid nerve (motor); 4, inferior dental nerve; 5, lingual nerve; B, inferior dental foramen; 6, masseteric branch (motor); 7, long buccal; 8, internal pterygoid (motor); 9, external pterygoid (motor); 10, ascending branches of auriculotemporal; 11, auriculotemporal nerve; 12, mandibular or third division; 13, connection with facial nerve; 14, descending branches of auriculotemporal; 15, and 17, [illegible]; 16, foramen ovale.

tinues as a large nerve until it divides into a number of branches in the region of the anterior two-thirds of the tongue and floor of the mouth.

The chorda tympani nerve joins the lingual at right angles. It passes between the external and internal pterygoid muscles. (See Figs. 60, 84, 86, 104, 116, and 118.) The chorda tympani nerve is incorporated with the lingual and is distributed to the tongue. The lingual nerve also gives off small

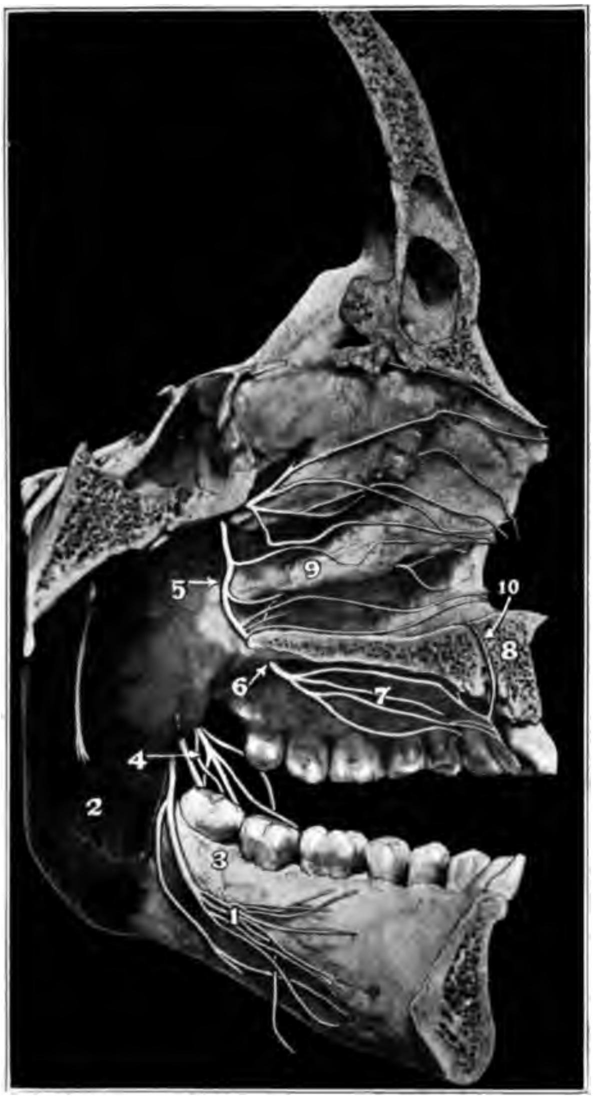


Fig. 97.—Nervus trigeminus (fifth cranial nerve). In the maxilla; nasopalatine part. (Modified and retouched from Quain.)

1, Lingual nerve; 2, internal pterygoid muscle; 3, alveolar border; 4, long buccal nerve; 5, anterior palatine nerve in the pterygopalatine canal; 6, anterior palatine nerve exiting through the posterior palatine foramen; 7, anterior palatine; 8, maxilla; 9, inferior concha; 10, nasopalatine nerve in nasopalatine canal.

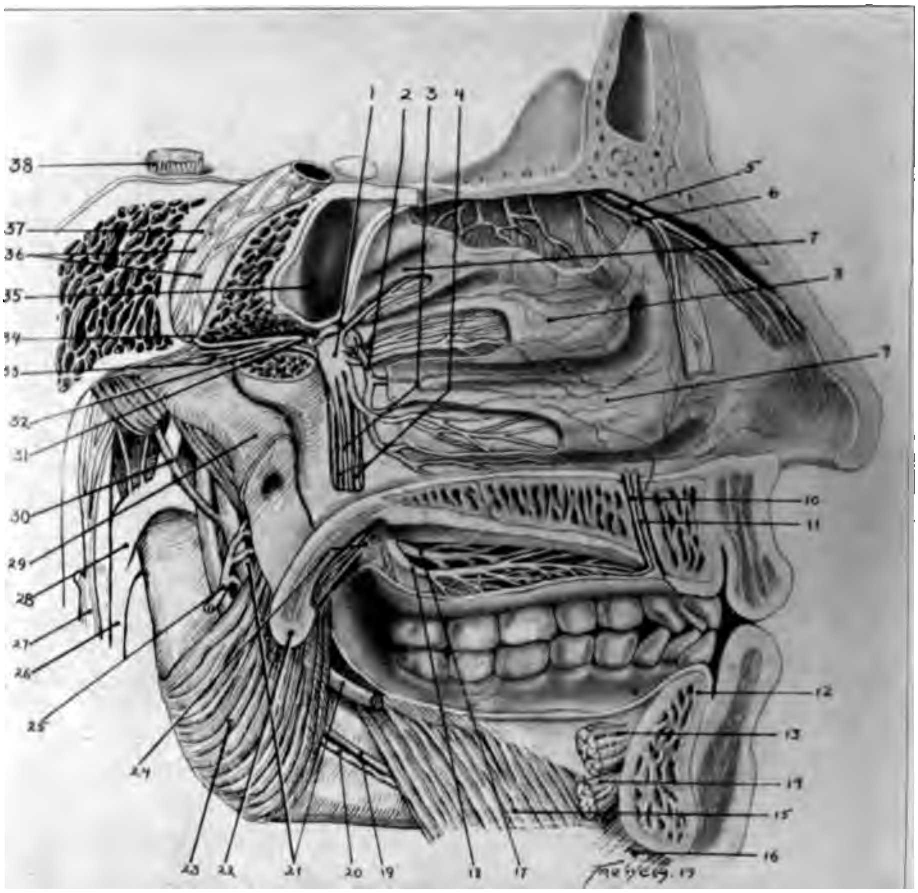


Fig. 98. Nerves and vessels of nose. (Retouched from Sobotta-McMurrich.)

1, Meckel's or palatine ganglion; 2, sphenopalatine artery; 3, descending palatine artery; 4, palatine nerve; 5, anterior nasal branch of anterior ethmoidal nerve; 6, anterior lateral nasal artery; 7, superior nasal concha; 8, middle nasal concha; 9, inferior nasal concha; 10, nasopalatine nerve; 11, posterior artery of nasal septum; 12, mandible; 13, genioglossus; 14, geniohyoideus; 15, mylohyoideus; 16, digastricus; 17, great palatine artery; 18, anterior palatine nerve; 19, mylohyoid nerve; 20, mylohyoid branch of inferior alveolar artery; 21, lingual nerve; 22, uvula; 23, internal pterygoid; 24, posterior palatine nerve and lesser palatine artery; 25, ascending palatine artery; 26, external carotid artery; 27, superior cervical ganglion of sympathetic trunk; 28, internal maxillary artery; 29, cartilage of tuba auditiva; 30, chorda tympani; 31, nerve of pterygoid canal; 32, artery of pterygoid canal; 33, great superficial petrosal nerve; 34, deep petrosal nerve; 35, sphenoidal sinus; 36, internal carotid plexus; 37, internal carotid artery; 38, trigeminal nerve.

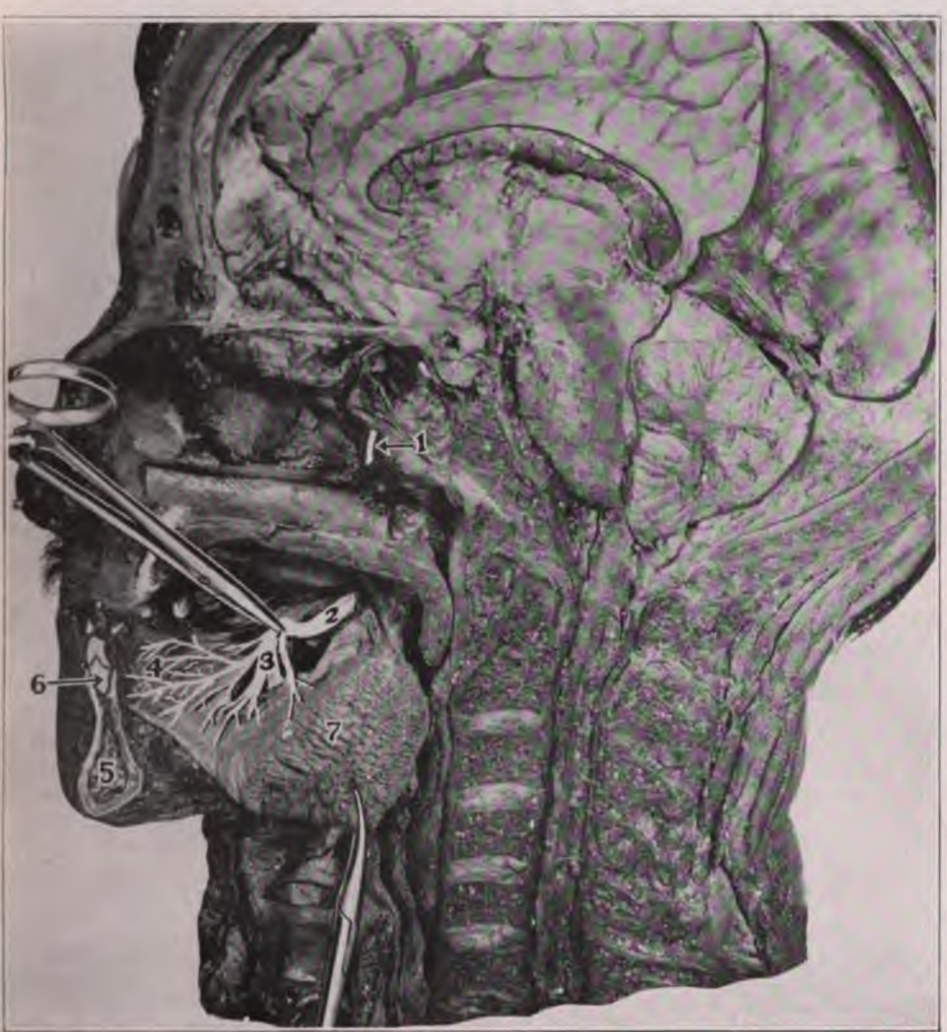
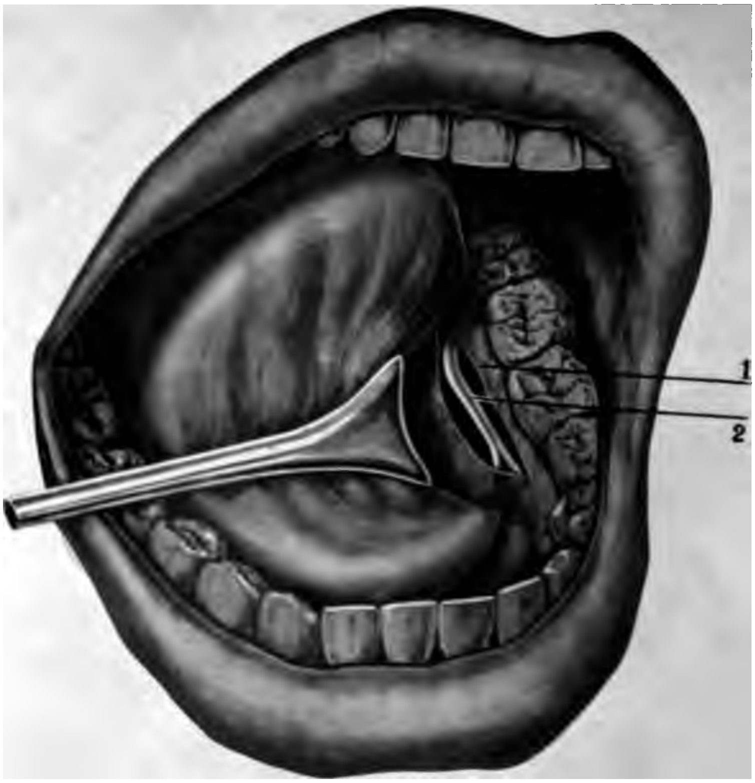


Fig. 99.—Dissected wet anatomical specimen illustrating the lingual and anterior palatine nerves.

1, Anterior palatine nerve in the pterygoidpalatine canal; 2, lingual nerve; 3, branches of the lingual nerve to the tongue; 4, branches of the lingual nerve to the floor of the mouth; 5, section of mandible; 6, right central incisor tooth; 7, dorsum of tongue.

branches which supply the mucous membrane of the fauces and tonsil; also branches to the submaxillary and sublingual ganglia, and communicating fibers with the inferior dental and hypoglossal.

The Inferior Dental Nerve.—This nerve is larger than the lingual and is at least 3½ mm. in diameter as it is given off the mandibular or third division. It enters the interval situated between the ascending ramus of the mandible and the sphenomandibular ligament and beneath the lower border of



[illegible] of last molar. 1, Oral [illegible]

the external pterygoid muscle. Its course at this point is downward, laterally, and slightly anteriorly (See Figs. [illegible] 91, 94, and 104.) It is located posterior to the lingual [illegible] enters the mandibular canal. It gives off [illegible] and which supplies the anterior [illegible] muscles with motor impulses. (See Figs. [illegible]) The course of the mylohyoid nerve is downward and [illegible] of the inferior maxillary bone [illegible] ramus of the mandible and the internal pterygoid muscle and later between the submaxillary gland and the mandible. The inferior dental nerve leaves the region between the lateral border of the internal pterygoid and the inner border of the ascending ramus and enters the inferior dental canal by passing through the inferior dental foramen. (See Figs. 86, 94, 96, 104, and 105.) The inferior dental foramen is located distal to the lingual nerve and is approximately 2 cm. below the lowest part of the sigmoid notch. (See Figs. 48 and 103.) It now courses downward and anteriorly in the mandibular or inferior dental canal (see Figs. 106, 108, and 110) in company with the vein and artery bearing the same name. (See Fig. 107.) It passes anteriorly in the ramus body of the inferior maxillary bone, giving off dental branches which enter the apices of the roots of the three lower molars, two lower bicuspids, cuspid and incisor teeth, and in addition, branches to the alveolar process and bone, buccal and labial gum tissue and periosteum situated in the region of the above-named teeth, mucous fold, portion of the lower lip and angle of the mouth.

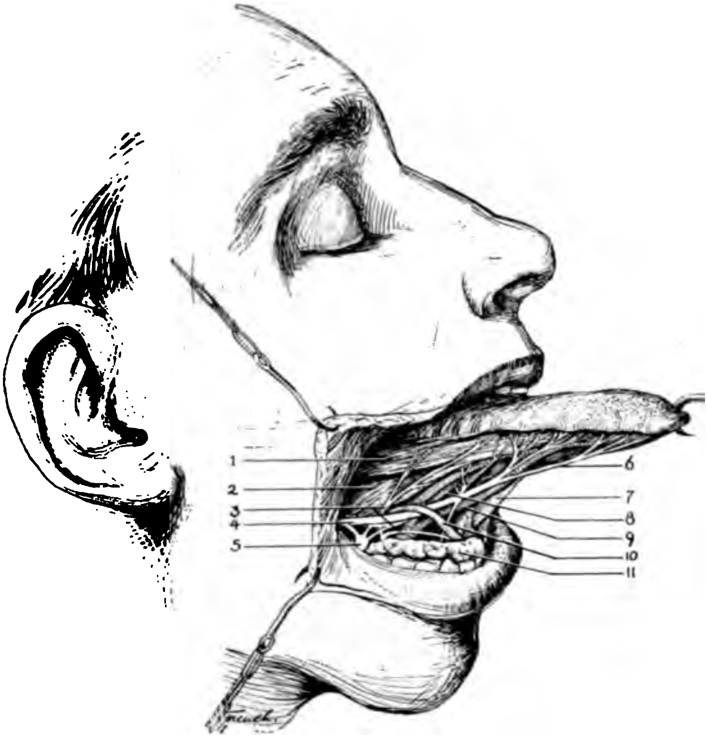


Fig. 101.—The lingual nerve. (Redrawn from Davis.)

1, Styloglossus muscle; 2, hyoglossus muscle; 3, hypoglossal nerve; 4, lingual nerve; 5, submaxillary ganglion; 6, lingual nerve; 7, geniohyoglossus muscle; 8, ranine artery; 9, ranine vein; 10, sublingual gland; 11, submaxillary duct.

The Mental Nerve

The principal branch of the inferior dental nerve is the **mental**, which leaves the inferior dental canal by way of the **mental foramen** and is divided into the labial and mental rami beneath the quadratus labii inferiors and triangularis muscles. (See Figs. 35, 40, 69, and 84.)

The mental ramus or branches supply the skin, while the labial ramus or branches supply the skin and mucous membrane of the lower lip and fold, gum tissue and periosteum, buccal and labial, in the region of the lower bicuspid, cuspid and lateral incisor teeth. (See Figs. 70, 96, 107, 112, and 113.)

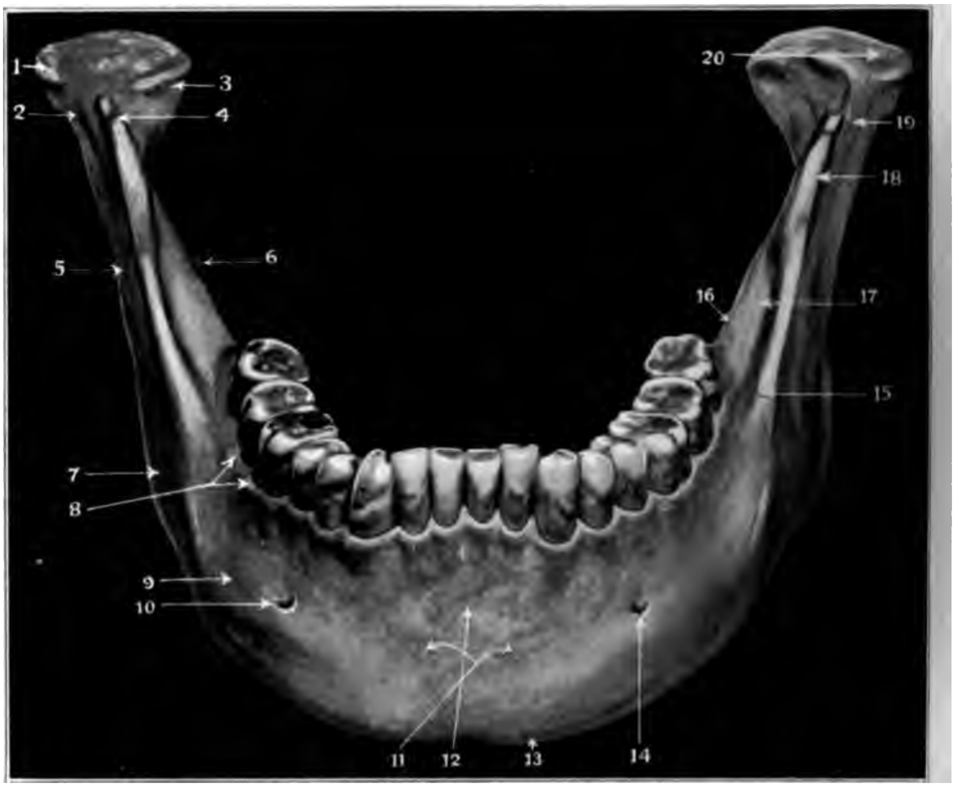


Fig. 102. The mandible or inferior maxillary bone. (Anterior.)

1, Condyle; 2, neck; 3, pterygoid depression; 4, coronoid process; 5, ramus; 6, lingula; 7, angle; 8, alveolar border; 9, body; 10, mental foramen; 11, incisive fossa and foramina of mandible; 12, symphysis; 13, mental tubercle; 14, mental foramen; 15, external oblique line; 16, internal oblique line; 17, retromolar fossa; 18, coronoid process; 19, sigmoid notch; 20, head of condyle.

The mental branches communicate with the ramus marginalis mandibulae of the seventh cranial or facial nerve.

The Incisive Nerve

After the mental branch is given off, the incisive nerve continues anteriorly in the canal, giving off small branches which enter the apices of the cuspid, central and lateral incisor teeth, also to the alveolar process and labial gum tissue, periosteum, mucous membrane and mucous fold, on the labial side of the above-named teeth. (See Figs. 69 and 111.) The inferior dental nerve and its branches correspond to the outer or external nerve loop in the upper jaw, because the former supplies similar structures to the latter. The lingual nerves and their branches correspond to the inner or medial nerve loop in the upper jaw, because lingual structures are supplied in both instances.

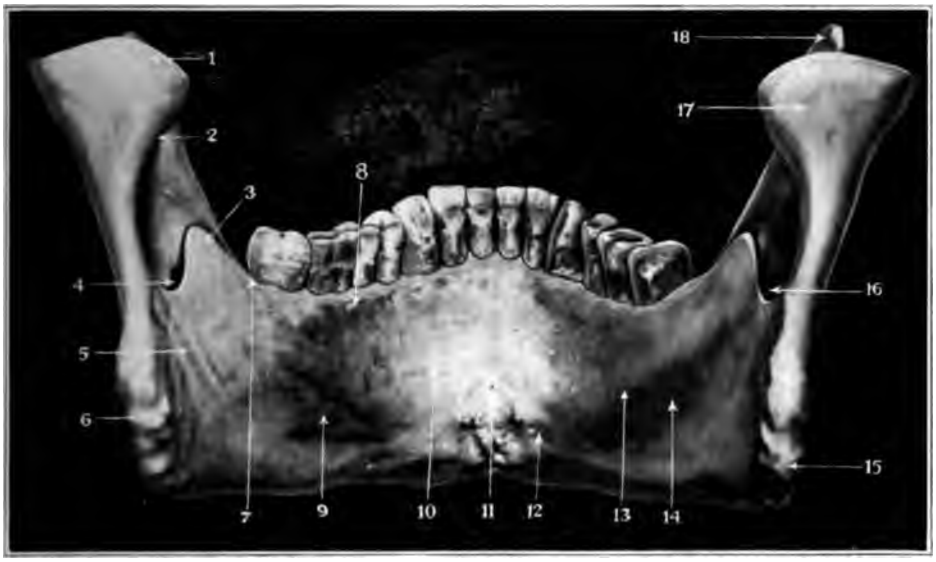


Fig. 103.—The mandible or inferior maxillary bone. (Posterior view.)

1, Condyle; 2, neck; 3, lingula; 4, mandibular foramen; 5, mylohyoid groove; 6, pterygoid tuberosity; **7, internal** oblique line; 8, alveolar border; 9, submaxillary depression; 10, sublingual depression; 11, **geniotubercles**; 12, digastric fossa; 13, mylohyoid ridge; 14, submaxillary depression; 15, angle of ramus; **16, mandibular** foramen; 17, condyle; 18, coronoid process.

Submaxillary Ganglion.—The submaxillary ganglion is flat or triangular, measuring approximately 2½ mm. in diameter. It is situated above the submaxillary gland on the external surface of the hyoglossus muscle about midway between the duct of the submaxillary gland and the lingual nerve. (See Figs. 84, 87, 95, 114, and 115.) It is composed of three roots which are as follows: *first*, a sympathetic root which receives its fibers from the external maxillary plexus, which is located upon the external maxillary artery; *second*, an afferent root from the lingual nerve which is sensory; *third*, an afferent

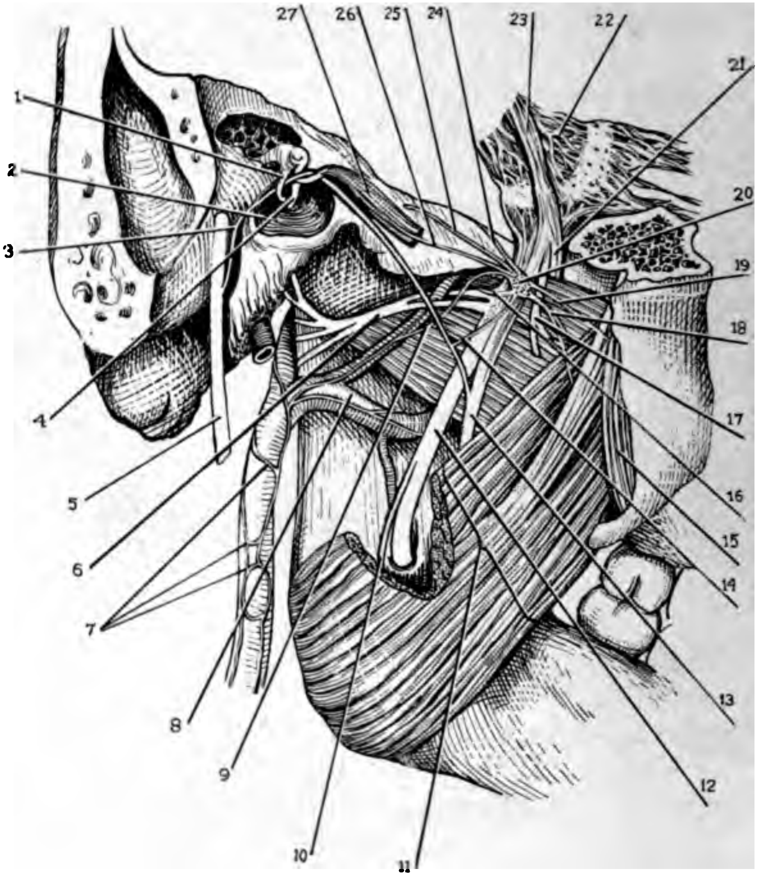


Fig. 101. The otic ganglion or ganglion of Arnold, ganglion oticum; its roots and branches. Displayed on the left side of the head, and viewed from within. (Redrawn from Toldt.)

1, Long process of the incus; 2, tympanic membrane; 3, chorda tympani nerve; 4, handle of the malleus; 5, facial nerve; 6, auriculotemporal nerve; 7, internal carotid plexus with its extensions, the internal maxillary plexus and the middle meningeal plexus; 8, middle or great meningeal artery; 9, sympathetic root of the otic ganglion; 10, mylohyoid nerve; 11, internal pterygoid muscle; 12, inferior dental nerve; 13, lingual nerve; 14, communicating branch to the chorda tympani nerve; 15, circumflexus or tensor palati muscle; 16, communicating branch to the auriculotemporal nerve; 17, external pterygoid nerve; 18, internal pterygoid nerve; 19, nerve to the tensor palati muscle; 20, otic ganglion, or ganglion of Arnold; 21, small anterior, or major portion of the inferior maxillary nerve; 22, large or sensory root of the fifth cranial, trifacial or trigeminal nerve; 23, small or motor root of the fifth cranial, trifacial, or trigeminal nerve.

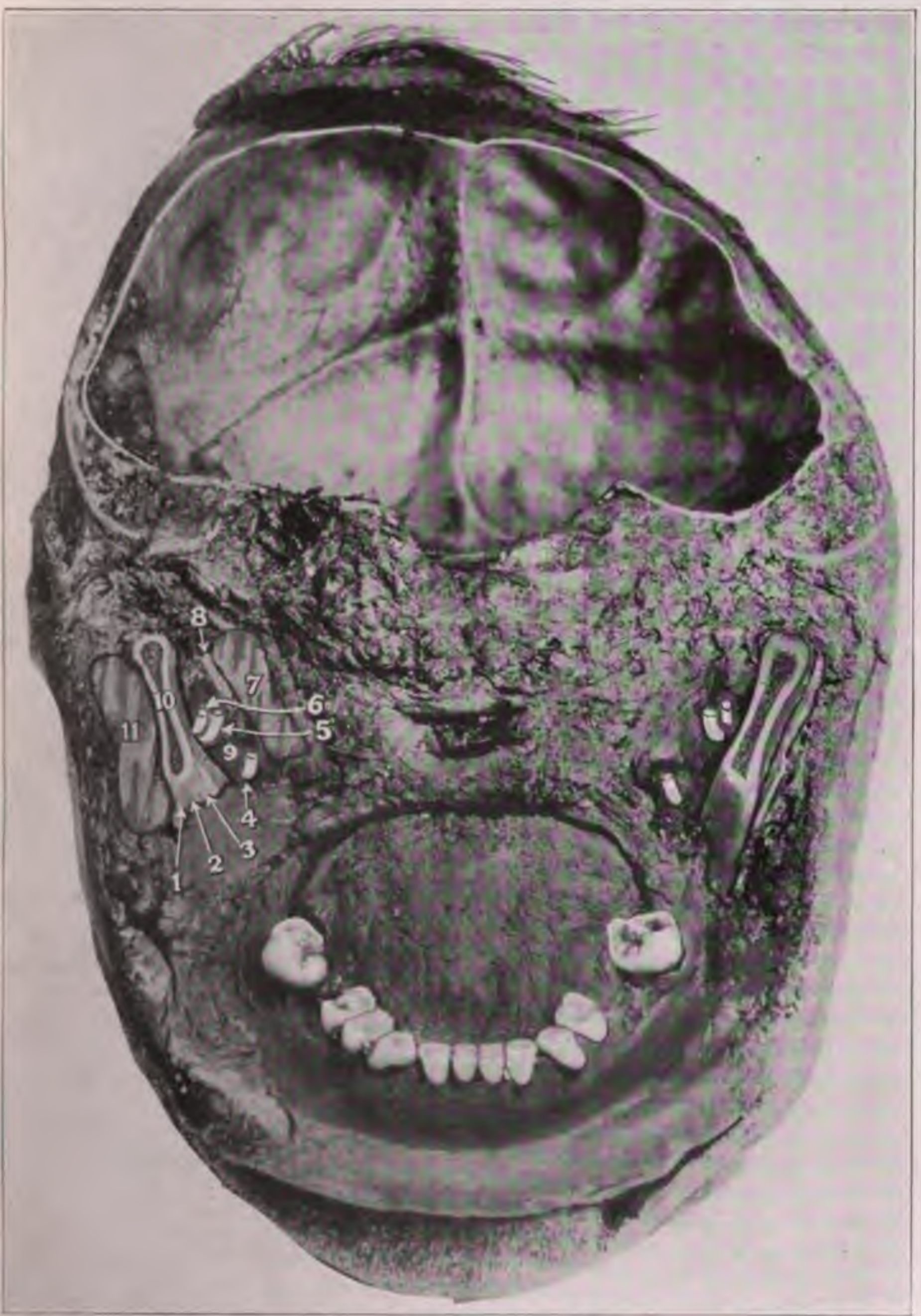


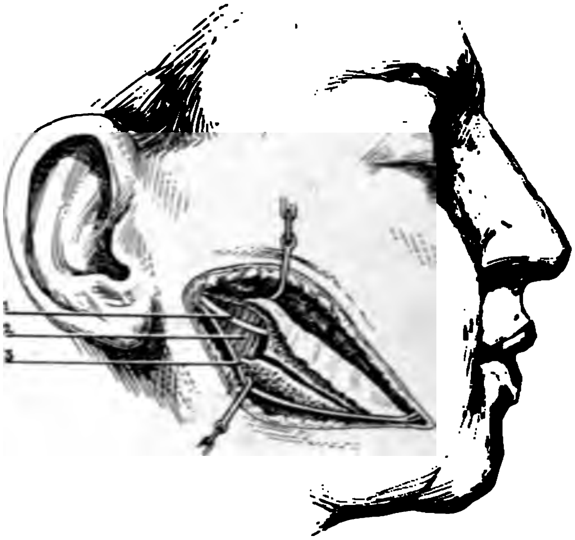
Fig. 105.—Dissected wet anatomical specimen incised at a level of one centimeter above the occlusal plane of the lower teeth.

1, External oblique line; 2, retromolar triangle; 3, internal oblique line; 4, lingual nerve; 5, inferior dental nerve; 6, inferior dental artery; 7, section internal pterygoid muscle; 8, section of sphenomandibular ligament; 9, connective tissue between lingual and inferior dental nerves; 10, section of ramus of mandible; 11, section of masseter muscle.

root which connects with the chorda tympani nerve. **Note accompanying** diagram for distribution.

SUBMAXILLARY GANGLION......ROOTS
- From chorda tympani of lingual and is both secretory and sensory.
- From plexus located on external maxillary artery and is sympathetic in function.

BRANCHES
- **To submaxillary gland.**
- **To mucous membrane and floor of mouth.**
- **Communicating branches with lingual of fifth nerve and hypoglossal or twelfth cranial.**



F.g [illegible] 3, inferior dental nerve.

The Sublingual Ganglion is a small structure located **near the sublingual** gland which it supplies, and its origin is from the **lingual nerve. Its action** is secretory. See Figs. 114 and 117.

The Otic Ganglion.—This ganglion is situated just **below the foramen ovale** and is a small, elongated structure. It is connected **with the trunk of the mandibular** nerve and in addition with several of its branches. (**See Figs. 86, 116,** 117, and 118. This ganglion is composed of three **roots.** ***First,* a sensory root** which is formed by the lesser superficial petrosal nerve. ***Second,* a motor** root which is derived from the nerve supply of **the internal pterygoid muscle.** *Third,* a sympathetic root which is derived from **the plexus which is situated** on the middle meningeal artery. This ganglion **gives off several communicating** branches which join the auriculotemporal, **chorda tympani and Vidian** nerves. Two motor nerves are also given off which supply **the tensor palati** and tensor tympani muscles.

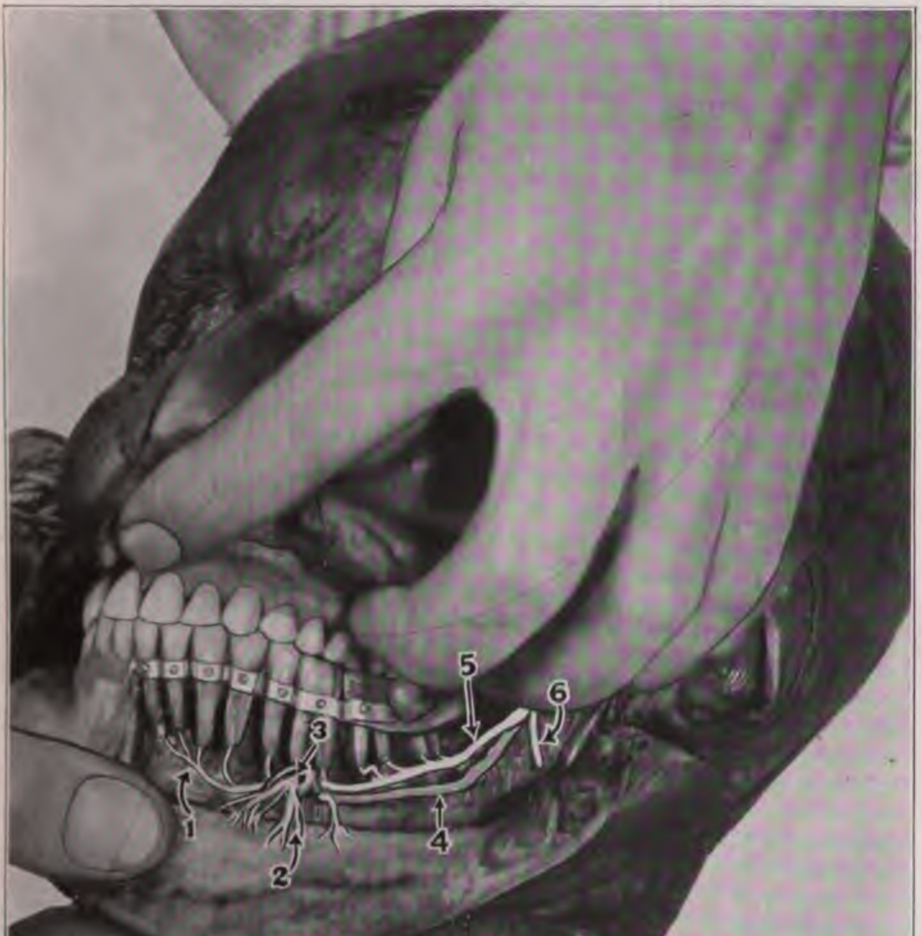


Fig. 107.—Dissected wet anatomical specimen illustrating the following structures:

1, Incisive nerves; 2, mental nerve; 3, mental foramen; 4, inferior dental artery; 5, inferior dental nerve; 6, inferior dental vein which has been incised.

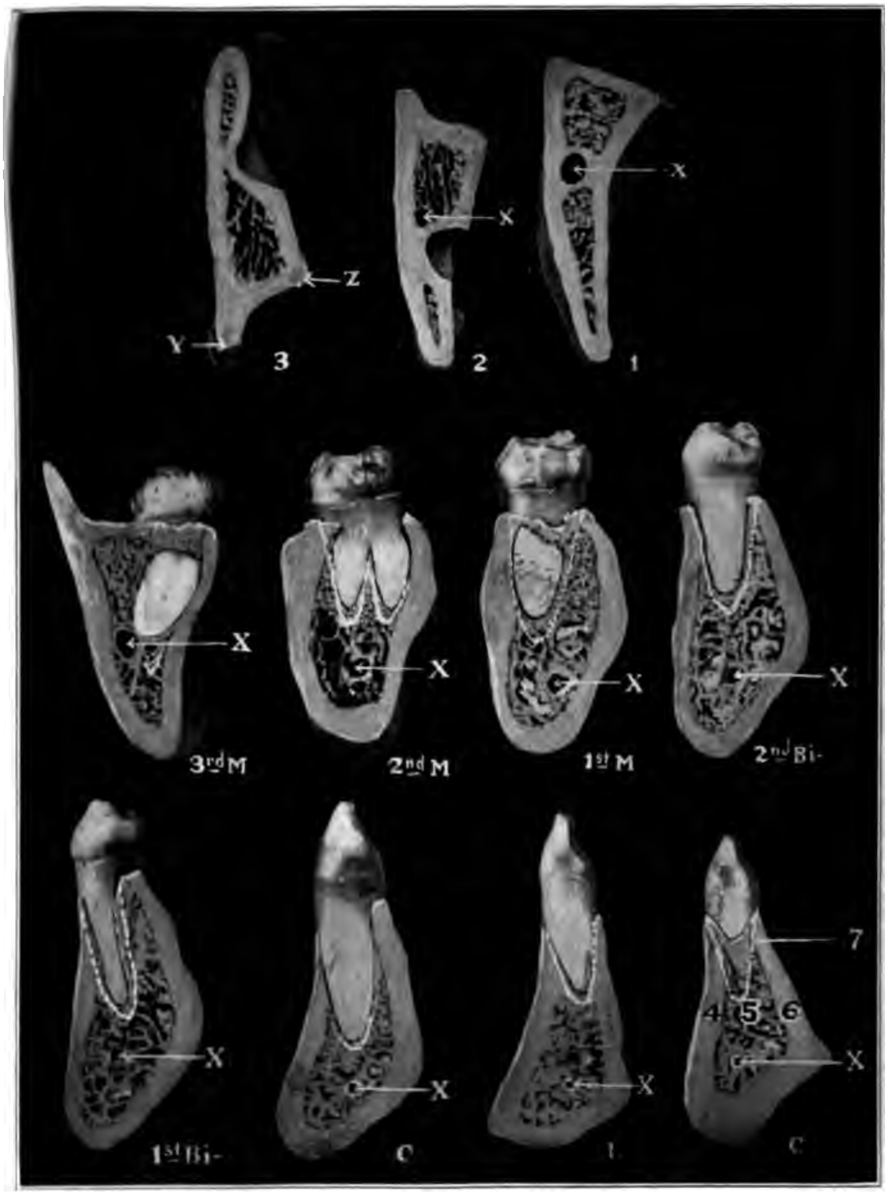
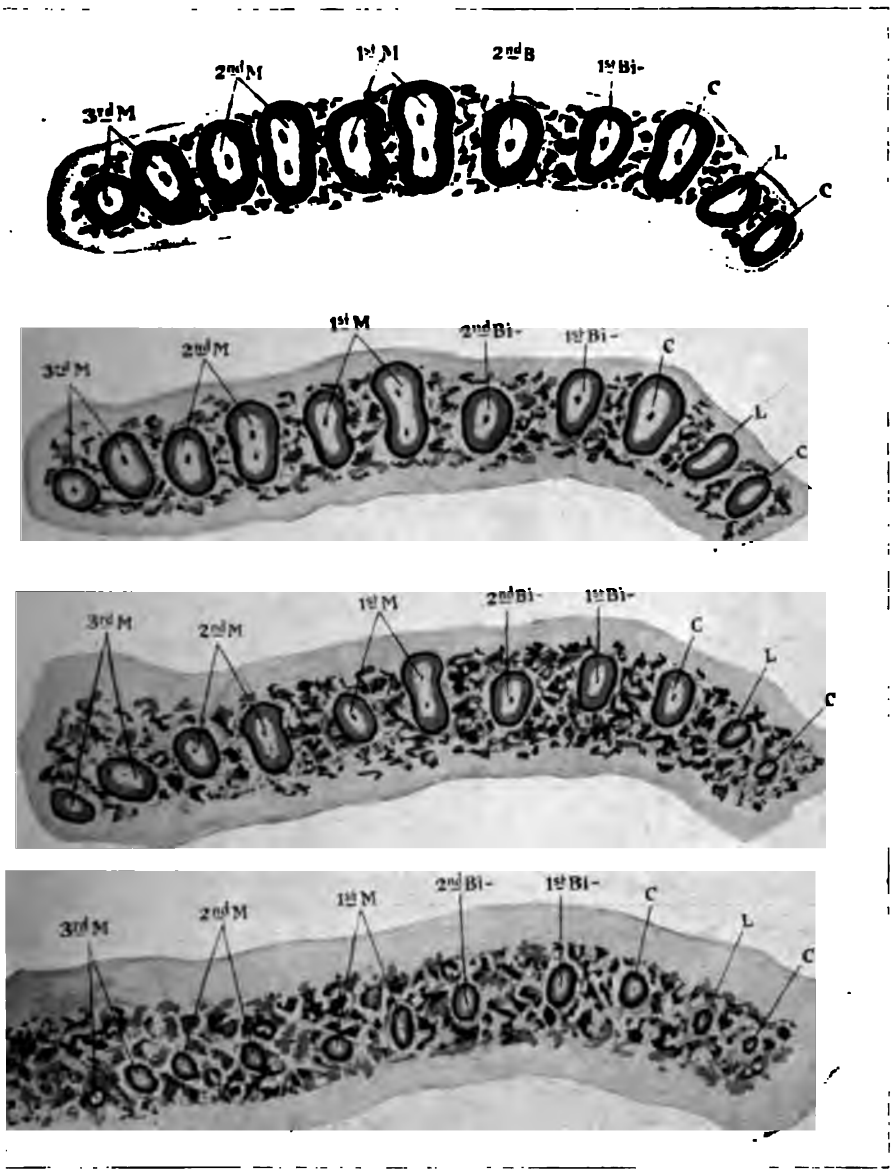


Fig. 108. Cross-sections of mandible or inferior maxillary bone through the mandibular sulcus, through inferior dental foramen and through the angle of the mandible and between the teeth. X represents inferior dental canal; Y, coronoid process and external oblique line; Z, internal oblique line. 1. Section through angle of ramus; 2, section through ascending ramus at inferior dental foramen; 3, section through mandibular sulcus; 4, labial alveolar plate; 5, middle plate of cancellous bone; 6, lingual alveolar plate; 7, outline of root of central incisor.



[illegible].—Sections through alveolar process of mandible and roots of teeth in four different planes.

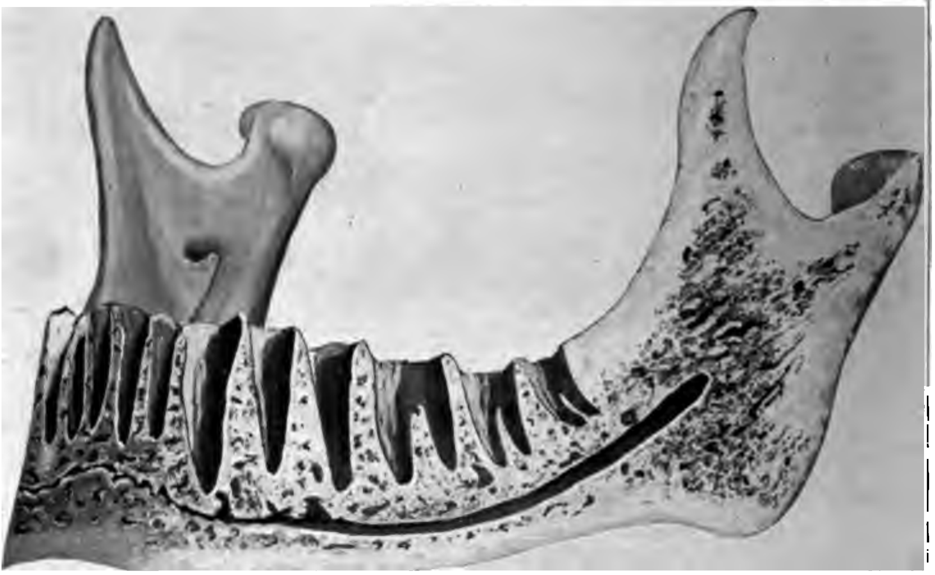


Fig. 110.—Specimen showing the inferior dental canal and alveoli, the external plate of bone being removed.

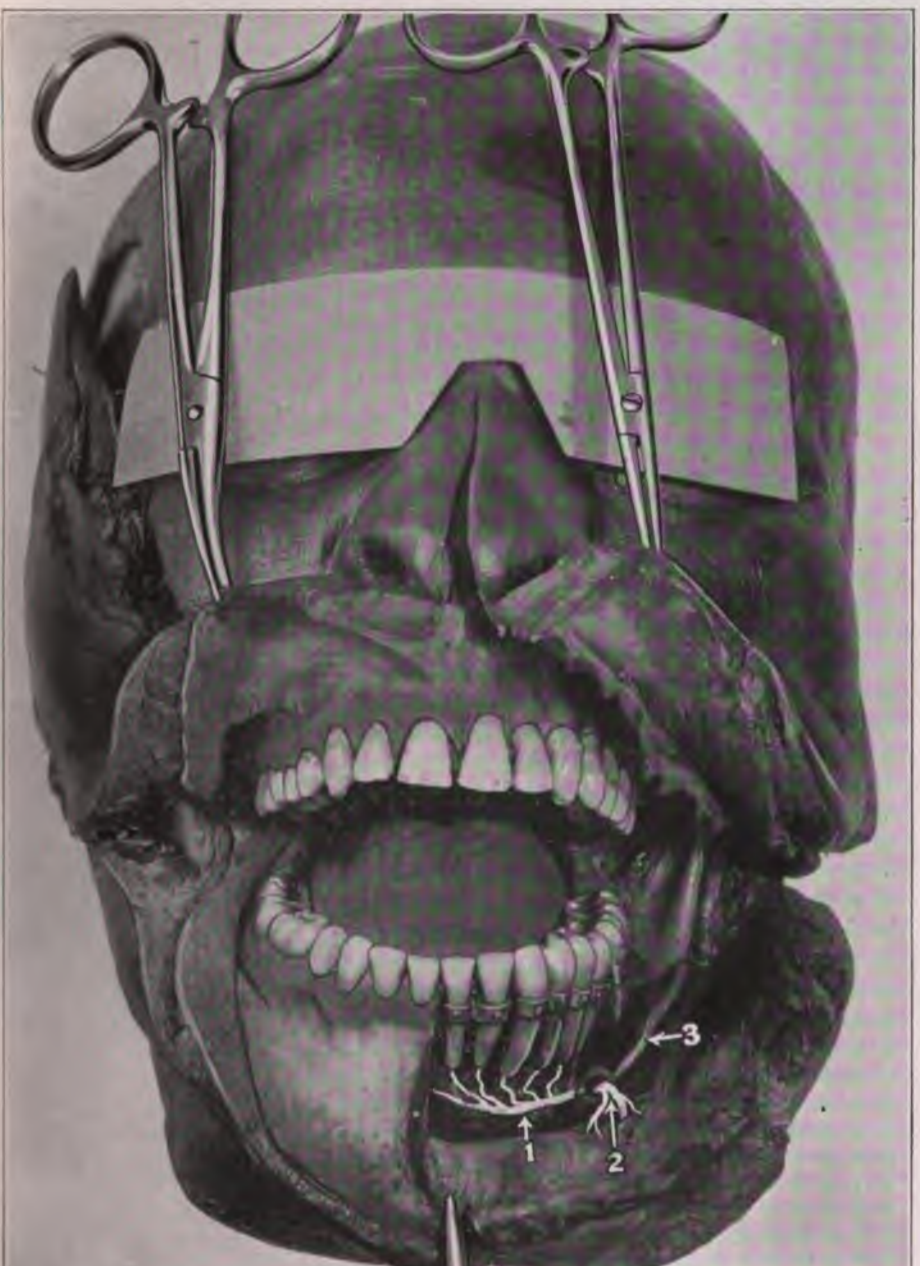


Fig. 111.—Dissected wet anatomical specimen showing the following structures: 1, Incisive nerve; 2, mental nerve; 3, inferior dental nerve.

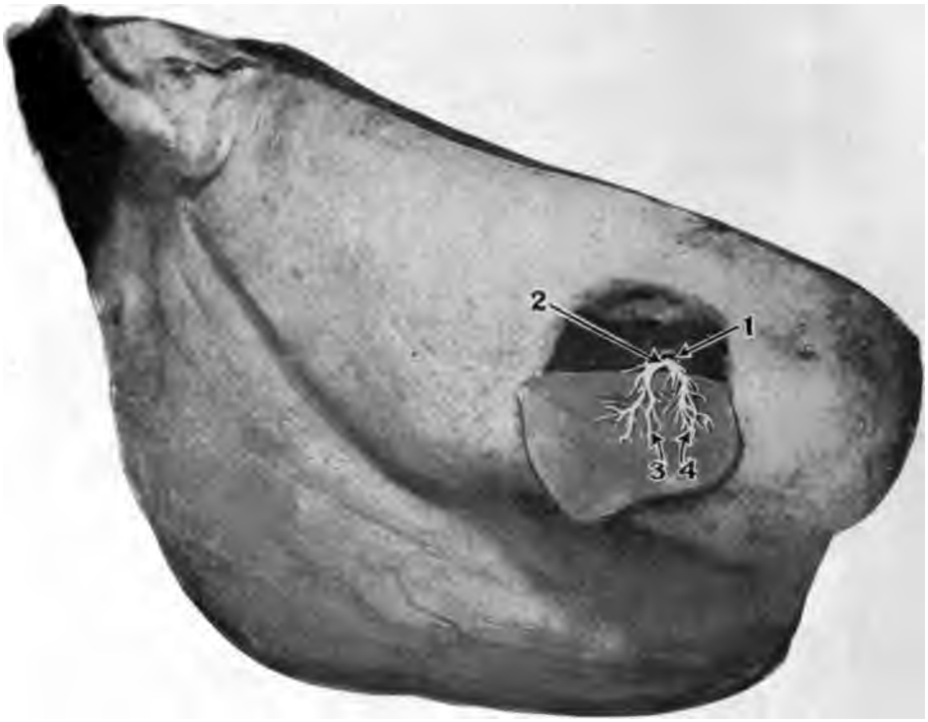


Fig. 112.—Dissected wet anatomical specimen showing the following structures: 1, Mental foramen; 2, mental nerve; 3, posterior ramus; 4, anterior ramus.

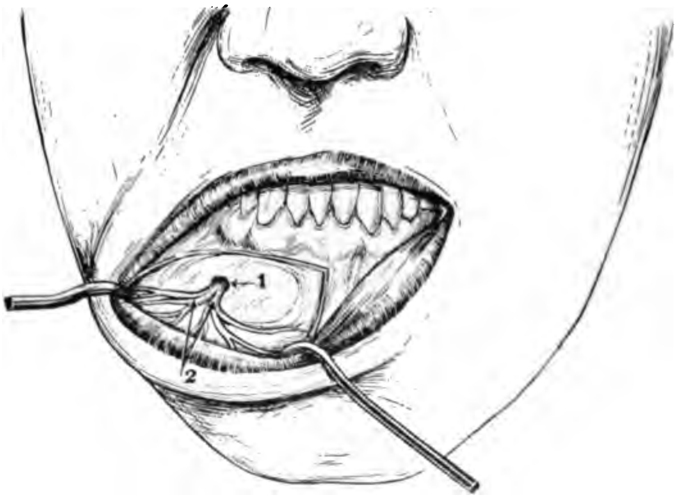


Fig. 113. 1, Mental foramen; 2, mental nerves.

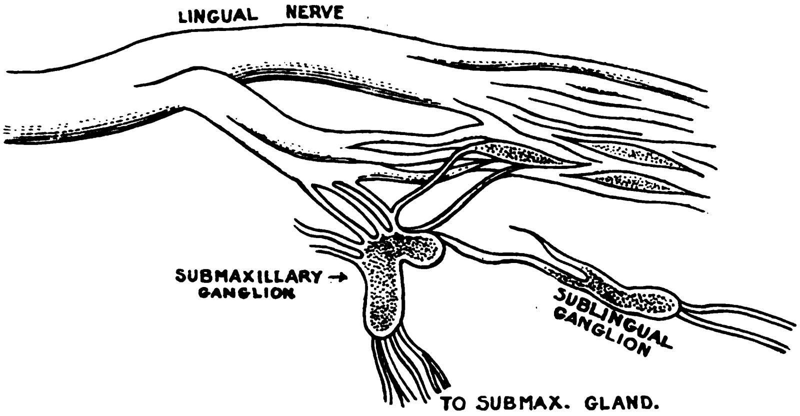


Fig. 114.—Submaxillary and sublingual ganglia of an infant. (Redrawn from Quain.)

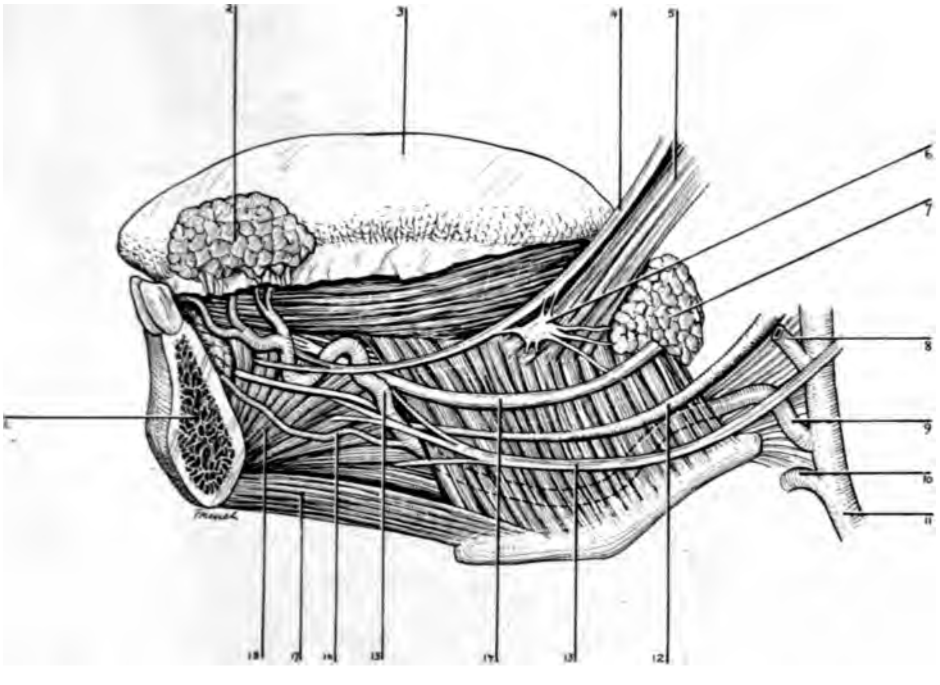


Fig. 115.—Deep dissection of the left submaxillary region. (Redrawn from Buchanan.)

1, Section of mandible; 2, sublingual gland (turned up); 3, dorsum of tongue; 4, lingual nerve; 5, styloglossus muscle; 6, submaxillary ganglion; 7, submaxillary gland (deep part); 8, facial artery; 9, lingual artery; 10, superior thyroid artery; 11, external carotid artery; 12, ranine vein; 13, hypoglossal nerve; 14, Wharton's duct; 15, ranine artery; 16, sublingual artery; 17, geniohyoid muscle; 18, geniohyoglossus muscle.

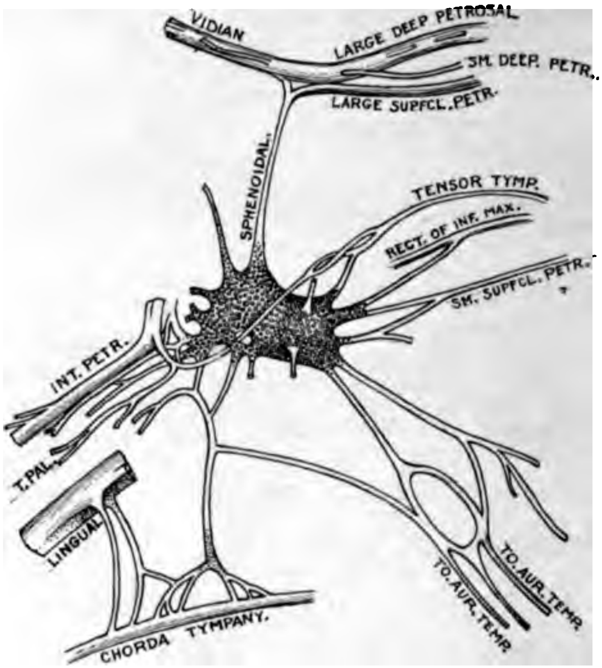


Fig. 116. The otic ganglion with its roots and branches. (Redrawn from Quain.)

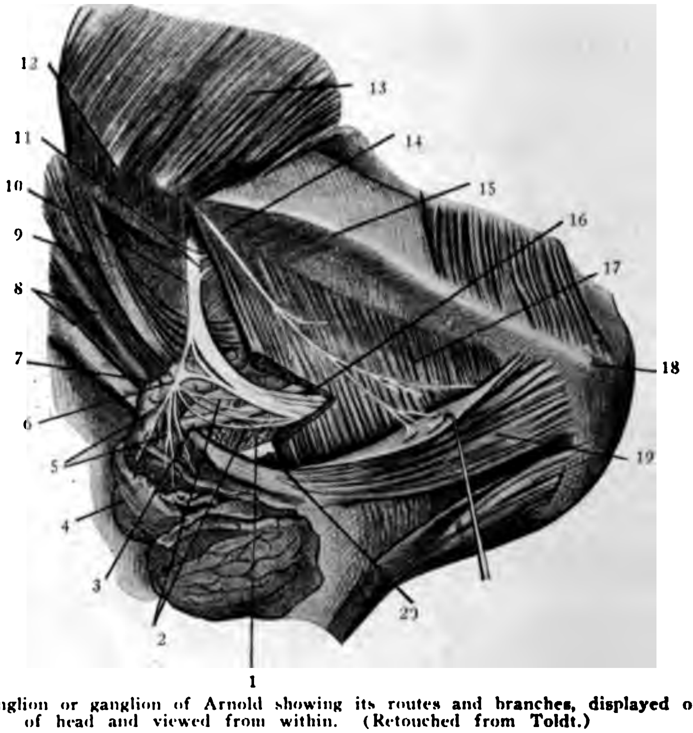


Fig. 117.—Otic ganglion or ganglion of Arnold showing its routes and branches, displayed on left side of head and viewed from within. (Retouched from Toldt.)

1, Hyoglossus muscle; 2, communicating branches to lingual nerve; 3, **submaxillary duct, or duct** of Wharton; 4, submaxillary gland (drawn downwards); 5, submaxillary **branches; 6, submaxillary or** lingual ganglion; 7, process of submaxillary gland; 8, stylohyoid **and digastric muscles; 9, styloglossus** muscle; 10, lingual nerve; 11, branches to isthmus of fauces; 12, **internal pterygoid muscle; 13, masseter** muscle; 14, mylohyoid nerve; 15, interior border or base of mandible; **16, sublingual nerve; 17, mylohyoid** muscle; 18, mental tubercle; 19, digastric muscle (anterior belly); **20, hypoglossal nerve.**

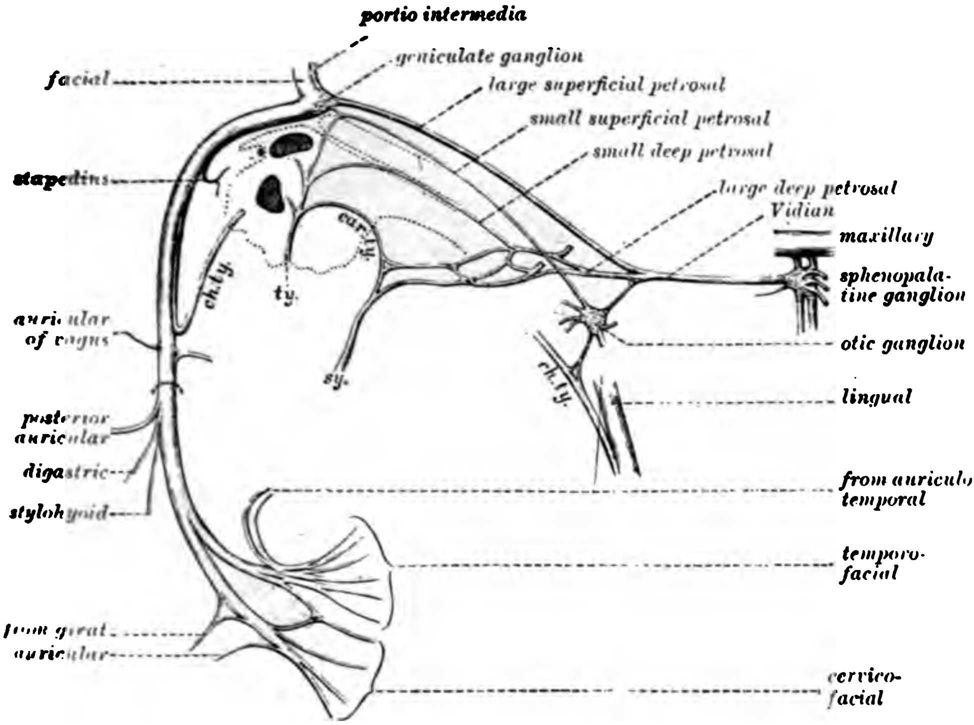


Fig. 118.—Plan of the facial nerve, with some of its communications. (From Quain.)

Ch.ty., chorda tympani; its middle part is removed; ty., tympanic branch of the glossopharyngeal; sy., sympathetic on the internal carotid artery; car.ty., carotico-tympanic nerve, passing between the tympanic nerve and the sympathetic in the carotid canal.

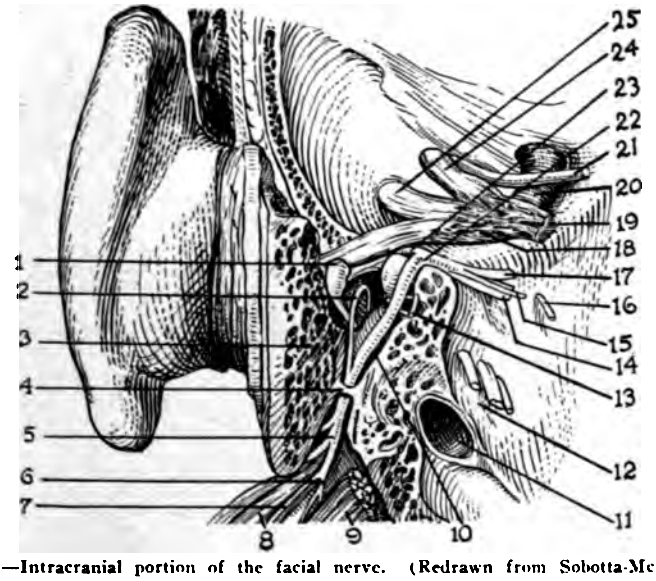


Fig. 119.—Intracranial portion of the facial nerve. (Redrawn from Sobotta-McMurrich.)

1. Malleus; 2, chorda tympani; 3, mastoid portion temporal bone; 4, stylomastoid foramen; 5, facial nerve; 6, digastric branch; 7, stylohyoid branch; 8, stylohyoideus; 9, digastricus; 10, facial canal; 11, transverse sinus; 12, glossopharyngeal, vagus and accessory nerves; 13, stapes; 14, acoustic nerve; 15, intermediate nerve; 16, abducent nerve; 17, facial nerve; 18, semilunar ganglion; 19, trigeminal nerve; 20, internal carotid artery; 21, oculomotor nerve; 22, geniculate ganglion of facial nerve; 23, great superior petrosal nerve; 24 ophthalmic nerve; 25, maxillary nerve.

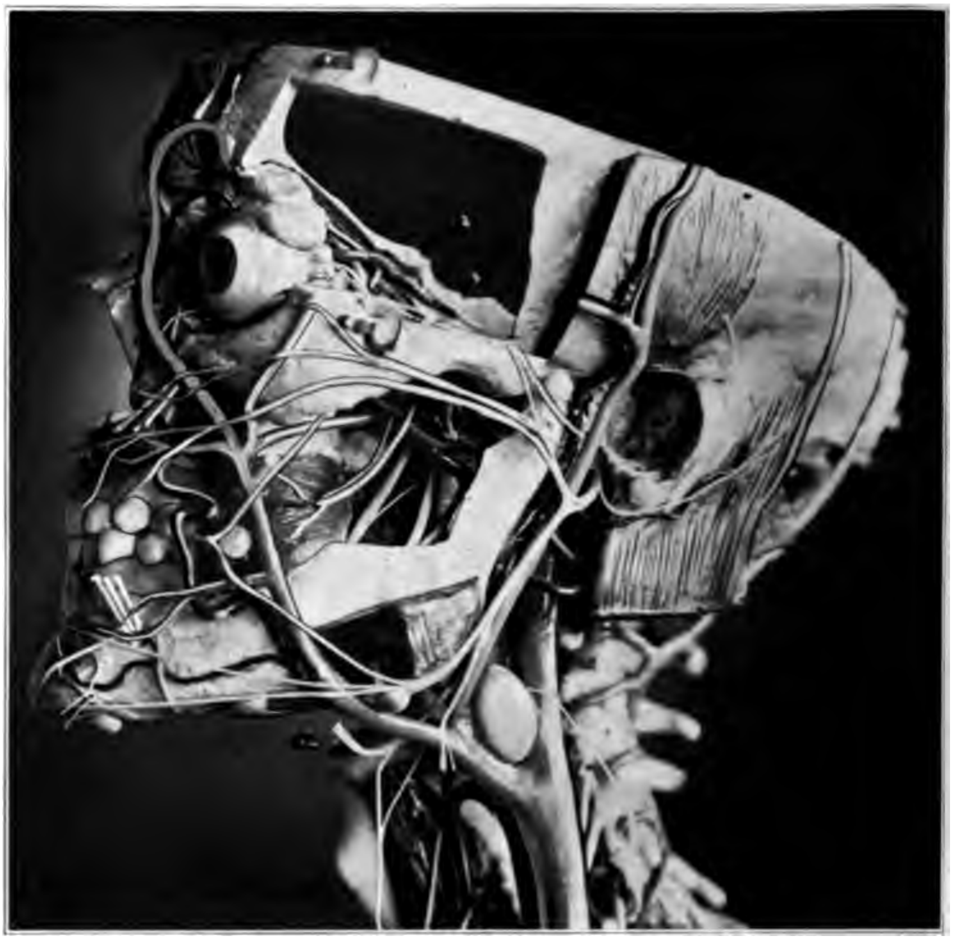


Fig. 120.—Anatomical specimen made of wax, paraffin, and silk in combination with skull, illustrating important anatomical structures of the head and neck. (Courtesy of the University of Tennessee.)

The following diagram gives the origin and distribution of the otic ganglion:

OTIC GANGLION	Roots	Secretory from superficial petrosal nerve Sympathetic, from meningeal plexus. Motor, from nerve supplying internal pterygoid muscle.	(Sensory) Branches	With internal pterygoid nerve. With Vidian nerve. With spinous recurrent nerve. With chorda tympani. With auriculotemporal. With nerve to tensor palati muscle. With nerve to tensor tympani.

The following diagram should aid the reader in obtaining an understanding of the divisions and subdivisions given off the posterior or lower division **the mandibular** nerve.

BRANCHES GIVEN OFF POSTERIOR OR LOWER DIVISION OF MANDIBULAR NERVE.

- AURICULO-TEMPORAL NERVE (SENSORY)
  - Superior and inferior external auditory branches to tympanic membrane and superior and anterior part of auditory meatus.
  - Communicates with facial nerve through temporo-facial
  - Communicates with otic ganglion.
  - Two anterior auricular branches
    - superior auricular
      - to superior part of auricle
    - inferior auricular
      - to Helix
      - to Tragus
  - Communicating branch to sympathetic system via plexus on maxillary artery.
  - Communicating branch to inferior dental or alveolar nerve.
  - Superficial temporal branches which are terminal branches to the skin of temple and scalp, and summit of head. Anastomoses with seventh cranial and the zygomaticotemporal of the fifth nerve.
- LINGUAL NERVE (SENSORY)
  - Branches to side and anterior two-thirds of tongue. mucous membrane floor of mouth, gum tissue, periosteum lingual to lower eight teeth on corresponding side. Communicates with and overlaps its fellow from opposite side at median line, forming inner nerve loop of lower jaw.
  - Branches to tonsil, anterior pillar, mucous membrane and isthmus of fauces.
  - Communicating or anastomosing branch with hypoglossal or twelfth cranial nerve.
  - Communicating or anastomosing branch with chorda tympani nerve.
  - Communicating or anastomosing branch with inferior dental or alveolar nerve.
  - Branches to sublingual ganglion.
  - Branches to submaxillary ganglion.
- INFERIOR DENTAL OR ALVEOLAR NERVE (SENSORY EXCEPT MYLOHYOID)
  - (Motor) Mylohyoid branch to anterior belly digastric and mylohyoid muscles for motor impulses.
  - Dental branches to (before inferior dental divides into mental and incisor divisions)
    - To lower molar teeth.
    - To lower bicuspid teeth.
    - To alveolar process and bone in region of lower molars and bicuspids.
    - To buccal gum tissue, periosteum, mucous membrane and mucous fold.
  - Incisive branch
    - To lower cuspid, lateral and central incisor teeth.
    - To alveolar process and bone in region of lower incisors and cuspid.
    - To gum tissue, periosteum, mucous membrane at fold labial to incisors and cuspid.
  - Mental branch
    - Labial ramus or branches
      - To mucous membrane and fold of lower lip.
      - To skin of lower lip.
      - Communicates with facial nerve through mental plexus.
    - Mental ramus or branches
      - To skin of angle of mouth and chin.
      - To gum tissue, periosteum, mucous fold buccal to lower bicuspids and cuspid.
      - Communicates with facial nerve through mental plexus.

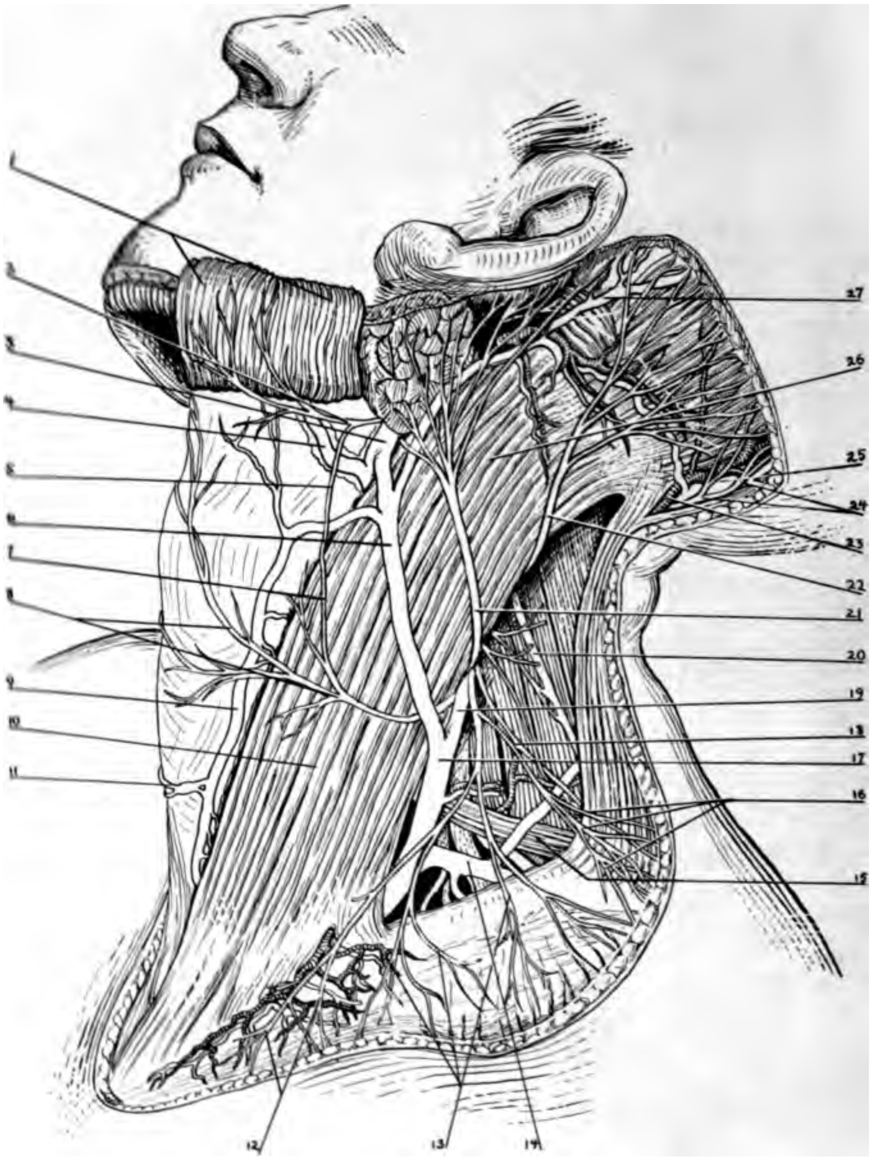


Fig. 191. Superficial nerves and veins of the left side of the neck. (Redrawn from Sobotta-McMurrich.)

1, Platysma muscle; 2, cervical branch of facial nerve; 3, posterior facial vein; 4, anterior facial vein; 5, anastomosis with cutaneous cervical nerve; 6, external jugular vein; 7, anastomosis with facial nerve; 8, cutaneous cervical nerve; 9, anterior jugular vein; 10, sternocleidomastoideus; 11, jugular venous arch; 12, anterior supraclavicular nerves; 13, middle supraclavicular nerves; 14, branch external jugular vein; 15, omohyoideus (anterior belly); 16, posterior supraclavicular nerves; 17, external jugular vein; 18, muscular branch of cervical plexus; 19, communication of external jugular veins with deep veins; 20, accessory nerve (external branch); 21, great auricular nerve; 22, lesser occipital nerve; 23, occipital artery; 24, great occipital nerve; 25, occipital vein; 26, sternocleidomastoideus; 27, posterior auricular vein.

CHAPTER VIII

ANATOMY

1. **Internal Maxillary Artery.**
2. **Pterygopalatine (Sphenomaxillary) Fossa.**
3. **Lingual Artery.**
4. **External Maxillary (Facial) Artery.**
5. **Muscles of Mastication.**
6. **Mucous Membrane, Gum Tissue, Peridental Membrane, and Periosteum.**

Internal Maxillary Artery

The author deems it necessary for practical purposes to include the internal maxillary artery and its branches in this text on account of its important location and of the many branches which supply the operative field of the oral surgeon and dentist.

The internal maxillary artery is the larger terminal branch of the external carotid and arises on a level of the lower part of the lobule of the ear. (See Figs. 122 and 124.) At its origin which is about midway between the anteromedial aspect of the parotid gland and the neck of the condyle of the mandible, it is embedded within the substance of the parotid gland. This artery passes opposite to the sigmoid notch and is located, in most instances, just above the lower border of the zygoma. When it is located just below the zygoma, it may be in danger when inserting the needle through the sigmoid notch into the region of the foramen ovale. (See technic for blocking the third division of the fifth nerve; extraoral method, page 525.)

This large artery terminates in the pterygopalatine fossa. (See Figs. 65, 66, 125, and 126.) Its branches correspond somewhat to those of the second and third divisions of the fifth nerve. Soon after this artery arises from the external carotid, it passes posterior to the neck of the mandible, then across its inner surface and in a most tortuous manner anteriorly between the temporal and external pterygoid muscles. After passing through the temporal fossa, it enters the pterygopalatine fossa. The artery is a comparatively short structure, but it gives off many branches and has many important relations. For convenience of its anatomic study, the branches which it gives off are divided into three parts. (See Fig. 123.)

The maxillary, or first part, is located between the posterior aspect of the neck of the mandible and the infratemporal fossa. The inferior border of the external pterygoid muscle is the dividing line. It is also situated between the neck of the mandible and the sphenomandibular ligament.

The pterygoid or second part courses superiorly and anteriorly and is located within the infratemporal fossa. This part is situated either to the medial or lateral side of the head of the external pterygoid muscle. If it is situated external to the lower head of the external pterygoid muscle, it is located between the external pterygoid and temporal muscles; in case it is located on the medial side of the lower head of the external pterygoid muscle it will be situated between the external pterygoid muscle and the mandibular branches of the fifth nerve.

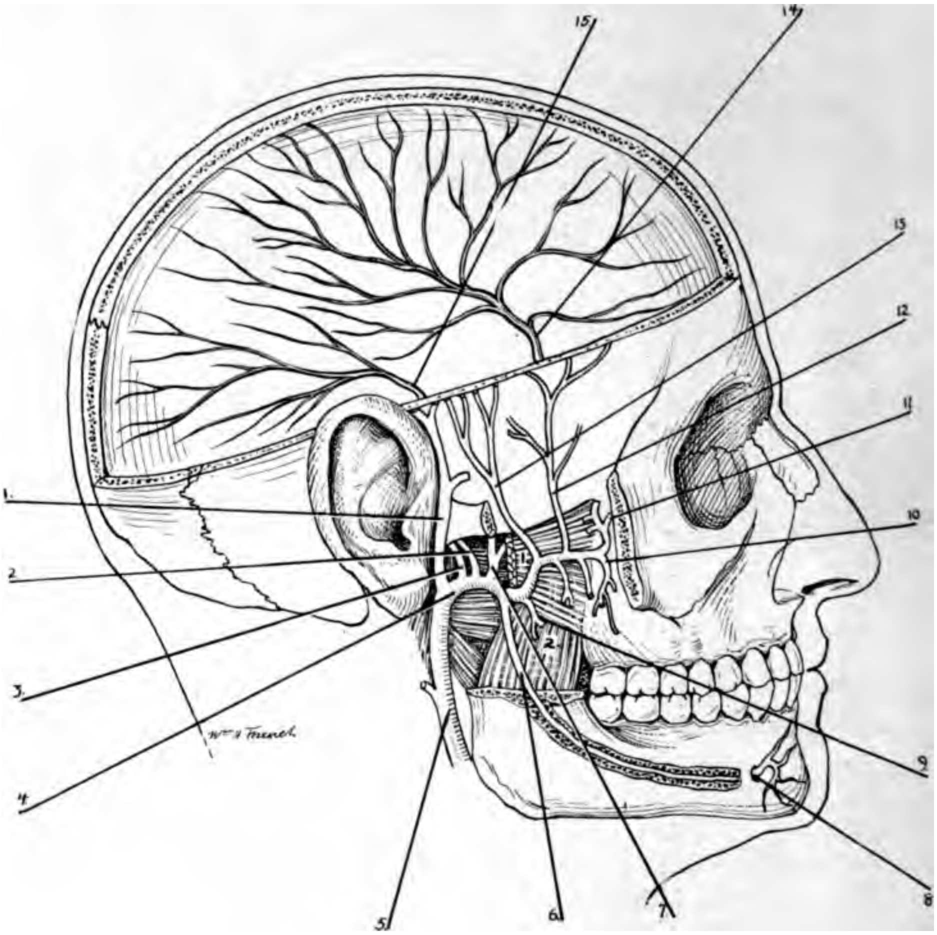


Fig. 122.—The internal maxillary artery and its branches. (Redrawn from Buchanan.)

1, Superficial temporal; 2, deep auricular; 3, tympanic; 4, internal maxillary; 5, external carotid; 6, inferior dental; 7, middle meningeal, giving off small meningeal; 8, mental; 9, pterygoid; 10, posterior dental; 11, infraorbital; 12, anterior deep temporal; 13, posterior deep temporal; 14, anterior division of the middle meningeal; 15, posterior division of the middle meningeal.

The sphenomaxillary or third part is situated between the upper and lower heads of the external pterygoid muscle and passes through the pterygoid maxillary fissure, and then enters the pterygoid palatine fossa. This part is very tortuous and is somewhat variable in its course. It is situated beneath the second division of the fifth nerve, in the sphenomaxillary fossa, and is located near the sphenopalatine ganglion.

It is not the intention of the author to cover all the minute details with reference to the anatomy of this artery and its branches, but in order to discuss it from the nerve blocking standpoint, the most important details must be included.

Let us now proceed to discuss briefly the branches which are given off the three parts of the artery. The diagram on pages 162 and 163 should be of assistance to the reader in obtaining a fair conception of this anatomic arrangement.

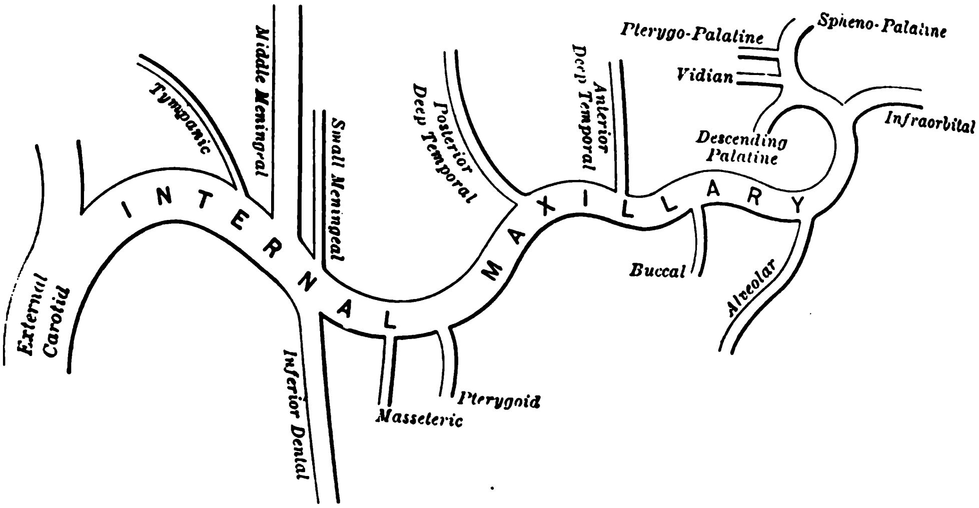


Fig. 123. -Diagram of internal maxillary artery and its branches. (From Gerrish.)

The internal maxillary artery itself is not often involved by oral operations, but its various branches may be involved to a considerable extent, and are highly important to the oral surgeon, as they often supply the operative field.

The inferior dental artery gives rise to a great deal of hemorrhage when the lower jaw is subjected to such operations as reducing a fracture, alveolectomy, tumors, or for the surgical removal of infected teeth or badly impacted third molars, etc.

The deep temporal branch gives troublesome hemorrhage when the temporal muscle is incised for the purpose of removing the Gasserian ganglion. The infraorbital branch is also highly important to the oral surgeon, for it is involved while operating on the infraorbital nerve, as for the surgical treatment of tic douloureux. The descending palatine branch passes downward in the posterior palatine canal in company with the anterior palatine nerve from Meckel's ganglion and emerges from the hard palate in the mouth through the posterior palatine foramen, and when operating for cleft palate this artery and its branches give a great deal of hemorrhage, and must be ligated.

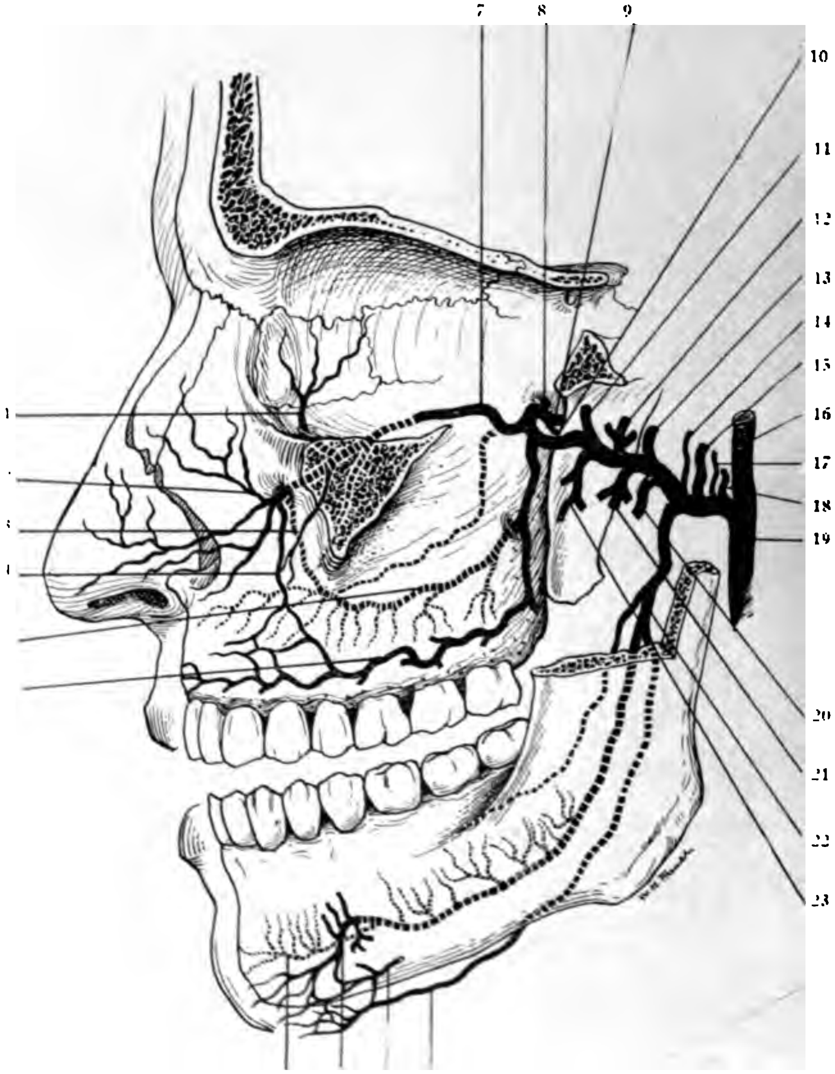
The roof of the pharynx is supplied by the pterygopalatine and Vidian branches, which are the cause of hemorrhage following the removal of adenoids. The spheno- and descending palatine branches supply the superior part of the tonsil and in many instances there results a serious hemorrhage following tonsillectomy. These same vessels give rise to considerable hemorrhage while operating on Meckel's ganglion. The nasopalatine artery passes downward and forward in the nose and is embedded in a groove on the vomer, and, following operations upon the nasal septum, it may bleed profusely unless checked.

The posterior superior alveolar branch enters the superior alveolar foramen with the nerves of the same name, which supply the alveolar process, part of the antrum, gum tissues, molars and bicuspid teeth in the upper jaw, and considerable hemorrhage follows an operation upon those tissues supplied by this artery. During the removal of the upper jaw, hemorrhage will occur from a number of the branches of the internal maxillary artery; there-

INTERNAL MAXILLARY ARTERY (Branch of external carotid)	First, or maxillary part.	1—Deep auricular branch	This supplies mandibular joint, the parotid gland, tympanic membrane and external acoustic meatus.
		2—Tympanic branch	Passes upward and posteriorly, passing through petro-tympanic fissure entering the tympanum.
		3—Middle meningeal branch	This is largest branch from parent trunk. It passes superiorly on the external surface of internal pterygoid muscle to foramen spinosum. Before this branch enters the skull it is situated behind the mandibular division of the fifth nerve. This artery gives off six branches.
		4—Small meningeal branch	Passes upwards medial to external pterygoid muscle, passing through foramen ovale supplying Gasserian ganglion.
		5—Inferior dental branch	Passes downward between sphenomandibular ligament and ramus of lower jaw to inferior dental foramen. Before entering foramen it gives off a lingual branch which accompanies lingual nerve and mylohyoid which descends in mylohyoid groove with the mylohyoid nerve to floor of mouth. Within the inferior dental canal it supplies by means of small branches the alveolar process and teeth. It divides into the incisive branch which continues in canal and mental branch which passes out through mental foramen to supply the muscles and integument of the chin.

	SECOND, OR PTERYGOID.	Anterior and posterior deep branches	These branches pass upward in temporal fossa supplying the temporal muscle.
		Pterygoid branches	These branches supply the pterygoid muscles.
		Masseteric branches	These branches supply the masseter muscle.
		Buccal branches	These branches supply the buccinator muscle, mucous membrane of cheek and neighbering facial muscles.
NTERNAL AXILLARY RTERY ONT'D Branch of external carotid)	THIRD, OR PTERYGOID PALATINE PART.	Posterior superior alveolar branch	This branch passes downward and laterally and enters the posterior superior alveolar foramen of maxillary tuberosity with the posterior superior alveolar nerve. It supplies upper molar and bicuspid teeth, gum tissue, maxillary sinus, mucous membrane, etc.
		Infraorbital branch	Passes through infraorbital canal of superior maxillary bone, and in the canal it gives off anterior superior alveolar artery which accompanies nerve of same name in anterior wall of antrum supplying the process, cuspid and incisive teeth, gum tissue, mucous membrane, etc. The infraorbital artery passes through infraorbital foramen upon face supplying tissue in that region.
		Descending palatine branch	Passes downward through palatine fossa and through pterygopalatine canal and divides into greater and lesser palatine branches. The foramen is a continuation of the descending palatine and runs forward in roof of mouth medial to alveolar process to terminate in a small branch which ascends through the incisive foramen. It also supplies the mucous membrane and gum tissue and hard palatine. The latter supplies the soft palate, palatine arch and tonsil.
		Vidian branch	This is sometimes given off descending palatine. It supplies Eustachian tube and pharynx.
		Naso- or spheno-palatine branch	This is largest artery in nasal cavity. It passes through sphenopalatine foramen, entering nasal cavity and supplies posterior portions of outer nasal wall and nasal septum. Passes anteriorly along vomer.
		Pharyngeal branch	Supplies roof of nose and pharynx.

fore, for many operations, which are to be performed in the region of the internal maxillary artery, it is necessary to ligate the external carotid which assists the operator to an immeasurable extent to lessen the amount of hemorrhage.



[illegible] (Redrawn from Deaver.)

[illegible] artery; 3, labial branch; 4, ante- [illegible] artery; 8, sphenopalatine artery; [illegible] temporal artery; 12, external [illegible] artery; 15, middle meningeal [illegible] artery; 19, external carotid [illegible] artery; 23, buccal artery; [illegible] branch.

When blocking the second division of the fifth nerve by the intraoral method, according to the technic of the author, the needle passes anterior to the internal maxillary artery. (See technic of blocking of second division on page 380).

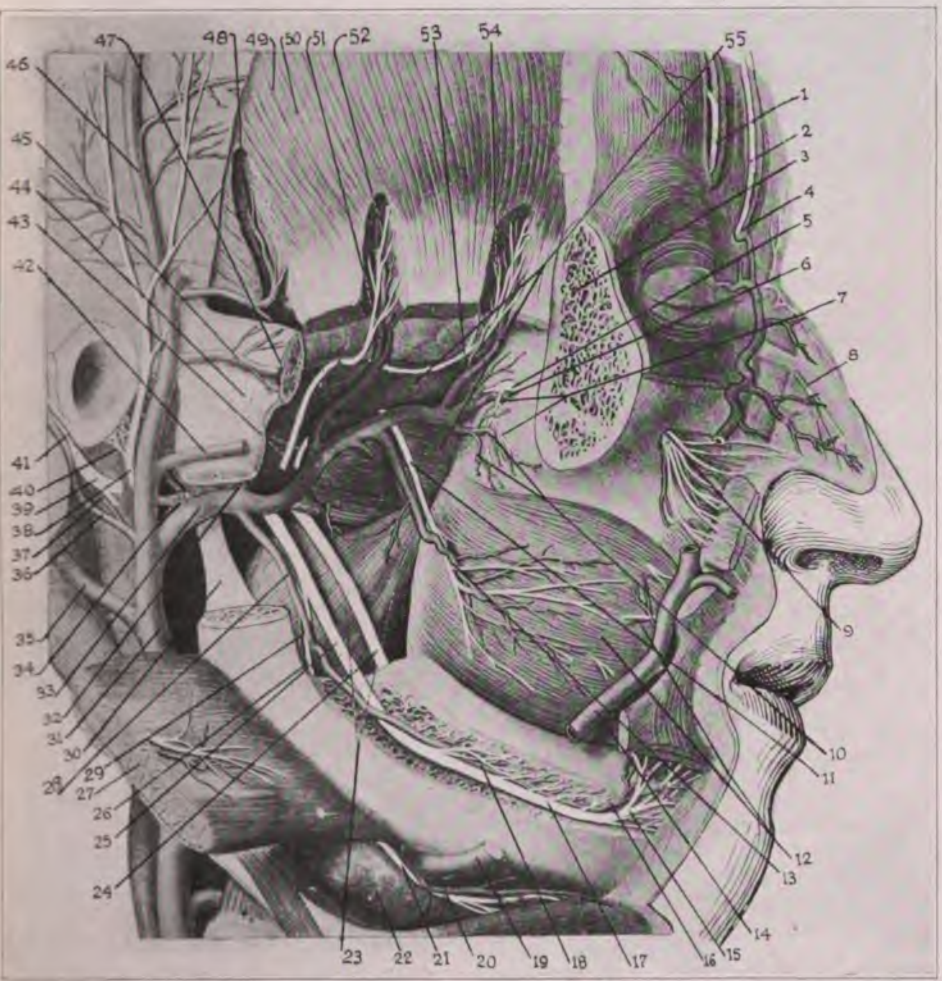


Fig. 125.—Nerves and vessels of the face. (Retouched from Sobotta-McMurrich.)

1, Supraorbital nerve; 2, frontal nerve; 3, xygomatic bone; 4, frontal artery; 5, infraorbital nerve; 6, infraorbital artery; 7, posterior superior alveolar nerves; 8, external nasal branch of anterior ethmoid nerve; 9, infraorbital nerve; 10, posterior superior alveolar arteries; 11, buccinator nerve; 12, buccinator muscle; 13, buccinator artery; 14, external maxillary artery; 15, mental nerve; 16, mental artery; 17, inferior alveolar nerve; 18, inferior alveolar artery; 19, external maxillary artery; 20, submental artery; 21, mylohyoid nerve; 22, submaxillary gland; 23, internal pterygoid muscle; 24, lingual nerve; 25, inferior alveolar nerve; 26, mylohyoid nerve; 27, masseter muscle; 28, inferior alveolar artery; 29, mylohyoid artery; 30, sphenomandibular ligament; 31, external carotid artery; 32, middle meningeal artery; 33, internal maxillary artery; 34, auriculotemporal nerve; 35, occipital artery; 36, posterior auricular artery; 37, stylomastoid artery; 38, auriculotemporal nerve; 39, facial nerve; 40, communicating branch auriculotemporal; 41, auricular branch of vagus; 42, transverse facial artery; 43, masseteric artery and nerve; 44, temporomandibular ligament; 45, zygomaticoorbital artery; 46, parietal branch of superficial temporal artery; 47, zygomatic arch; 48, middle meningeal artery; 49 and 50, temporal muscle; 51, posterior deep temporal artery; 52, posterior deep temporal nerve; 53, anterior deep temporal artery; 54, anterior deep temporal nerve; 55, external pterygoid muscle.

Pterygopalatine (Sphenomaxillary) Fossa

This fossa is located between the apex of the orbital cavity and is triangular in shape. It is bounded as follows (see Figs. 36, 51, 64, 227):

Anteriorly, by the tuberosity of the superior maxillary bone. It communicates anteriorly with the apex of the orbit via the inferior orbital fissure.

Posteriorly, by the pterygoid process of the sphenoid bone.

Medially, it is separated from the nasal cavity by the perpendicular portion of the palate bone.

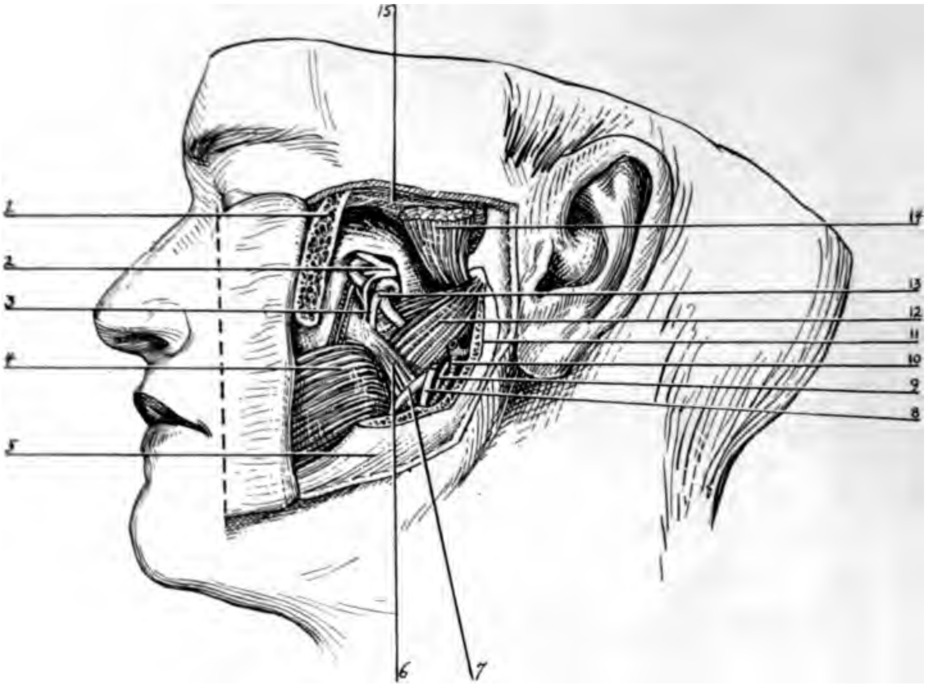


Fig. 126.

1, Zygomatic bone; 2, infraorbital nerve; 3, posterior superior dental; 4, buccinator muscle; 5, mandible; 6, internal pterygoid; 7, lingual nerve; 8, inferior dental nerve; 9, mylohyoid nerve; 10, inferior dental artery; 11, section of the ascending ramus; 12, external pterygoid; 13, internal maxillary artery; 14, external pterygoid; 15, temporal muscle.

Superiorly, it is bounded by the orbital process of the palate bone and the lower surface of the body of the sphenoid bone.

Laterally, it communicates with the infratemporal fossa via the pterygomaxillary fissure.

The pterygopalatine fossa has the following foramina opening into it: The foramen rotundum, the pterygoid canal and pharyngeal canal are located posteriorly; on the inner wall is located the sphenopalatine foramen; inferiorly is located the pterygopalatine canal and occasionally accessory palatine canals. It communicates with the nasal, orbital and zygomatic fossæ.

This fossa contains the second or superior maxillary division of the fifth nerve, posterior-superior alveolar nerves, the sphenopalatine nerves, the sphenopalatine or Meckel's ganglion and its branches, and the terminal branches of the internal maxillary artery. The width of the pterygopalatine fossa where it is crossed by the second division of the fifth nerve will vary from 10 to 15 mm.

If a transverse puncture is made with the nerve blocking needle, just beneath the zygomatic arch, and it is elevated to a considerable extent or in other words, directed too high and carried into the tissue too far, it may enter the posterior aspect of the orbital cavity, or if forced farther into the tissue it may enter the region of the orbital foramen. Last, but not least, if it is carried in more of an upward direction and inserted far into the tissue, it may pass through the sphenopalatine canal, thus entering the nasal fossa.

Deep nerve blocking injections require thorough knowledge of anatomy on the part of the operator in order to secure satisfactory results.

Lingual Artery

This artery arises from the external carotid artery on a level with the superior cornu of the hyoid bone. It is under cover of the posterior belly of the digastric and platysma muscles.

Course.—After its origin, it courses superiorly and medially to the medial surface of the hyoglossus muscle, and then passes forward in an almost horizontal direction and is located upon the under surface of the tongue, and in this location it gives off many small dorsolingual and hyoid branches. (See Fig. 101.) Near its termination it turns abruptly upward between the genioglossus and hyoglossus muscles and gives off several small terminal branches.

The following diagram gives the branches and structures supplied by each branch:

LINGUAL ARTERY BRANCHES	HYOID BRANCH.	This is a small branch which passes to the region of hyoid muscles and hyoid bone and anastomoses with its fellow from the opposite side in the median line.
	DORSOLINGUAL BRANCHES.	Several of these branches, which arise from the posterior aspect of the lingual artery, pass to and supply the dorsum of the tongue and mucous membrane in that region. Some branches supply the epiglottis and palatine tonsil.
	SUBLINGUAL BRANCH.	This is the smaller of the two terminal branches. It passes to the floor of the mouth beneath the sublingual gland and over the mylohyoideus and geniohyoideus muscles. It supplies the tissues in this region.
	DEEP LINGUAL BRANCH.	This is the largest terminal division. It reaches the tip of the tongue by passing superiorly and anteriorly assuming a very tortuous course and passes between the longitudinalis inferior and genioglossus muscles. Many small branches are given off which supply the muscles and mucous membrane of the tongue and floor of the mouth. It anastomoses with its fellow from the opposite side just above the lingual frenulum in the median line to form the ranine arch.

External Maxillary (Facial) Artery

This is a branch of the external carotid artery and arises at the inferior aspect of the posterior belly of the digastric muscle.

Course.—It passes superiorly along the medial aspect of the posterior belly of the digastric muscle until the submaxillary location is reached; then it assumes an almost horizontal position anteriorly near the inner surface of the lower part of the inferior maxillary bone. In this region it is partly covered by the submaxillary gland. This artery passes over the mandible at the anterior margin of the insertion of the masseter muscle to the outer ramus. After passing over the lower edge of the mandible, it winds its way obliquely upward over the face, in a very tortuous manner, until it reaches the root of the nose. (See Figs. 120 and 125.) Its branches and structures supplied are as follows:

EXTERNAL MAXILLARY (FACIAL) ARTERY BRANCHES	ASCENDING PALATINE BRANCH.	It passes superiorly along the lateral wall of the pharynx, pierces the pharyngeal wall and then along the pharyngopalatine arch reaching the soft palate, the fauces, nasopharynx, palatine tonsil. It anastomoses with the lingual ascending pharyngeal and descending palatine arteries.
	GLANDULAR BRANCHES.	Several small branches are given off which supply the submaxillary gland.
	SUBMENTAL BRANCH.	This branch is situated between the anterior belly of the digastric and mylohyoideus muscles and passes forward to chin supplying muscles, glands, skin, etc., and anastomoses with facial branches of facial artery, mental arteries and with its fellow on opposite side.
	INFERIOR LABIAL BRANCH.	It is given off facial at a level of the lower teeth and lateral aspect of the triangularis muscle and passes into the lower lip, supplying the tissue in this region, and anastomoses with its fellow on opposite side.
	SUPERIOR LABIAL BRANCH.	It is given off facial between the zygomaticus and the quadratus labii superioris muscles. It supplies the upper lip and a portion of the anterior part of nasal septum and communicates with its fellow on opposite side.
	ANGULAR BRANCH.	This is the terminal portion of the external or facial artery. It passes upward along the ala and dorsum of the nose to the inner angle of the eye. It is very tortuous and gives off many branches which supply the muscles, skin, etc., and anastomoses with other arteries at its termination.

Muscles of Mastication

There are five muscles of mastication which are as follows:

1. Masseter.
2. Temporal.
3. External pterygoid.
4. Internal pterygoid.
5. Buccinator.

The Masseter Muscle.—"The chewing muscle," situated in the back part of the side of the face. (See Figs. 127-128.)

Origin.—First, deep portion, from the posterior third of the lower border and the entire internal surface of the zygomatic arch. Second, superficial portion, from the anterior two-thirds of the lower border of the zygomatic arch. The direction of the superficial portion is downward and slightly backward, while the deep portion is downward and slightly forward. (See Figs. 127 and 128.)

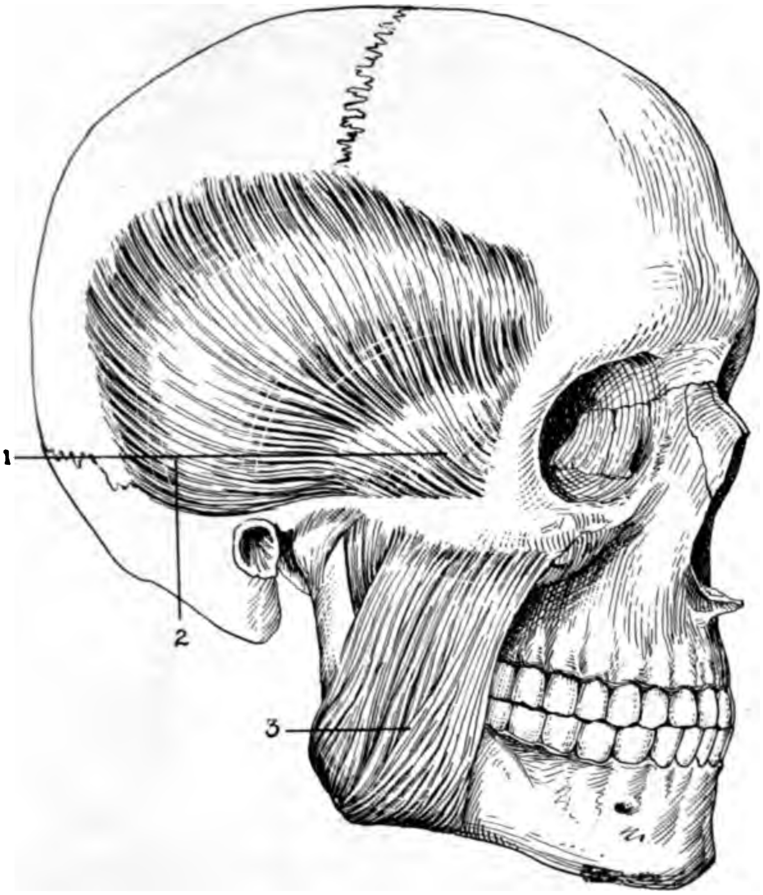


Fig. 127.—Illustrating the temporal and masseter muscles. (Redrawn from Benninghofen.) 1, fascia temporalis; 2, temporal muscle; 3, masseter muscle.

Insertion.—The deep portion inserts into the superior half of the outer surface of the ascending ramus of the mandible. The superficial portion inserts into the inferior half of the outer surface of the ascending ramus. (See Fig. 129.)

Nerve and Blood Supply.--The masseter muscle is supplied by the masseteric branch which is given off the anterior portion of the third or mandibular

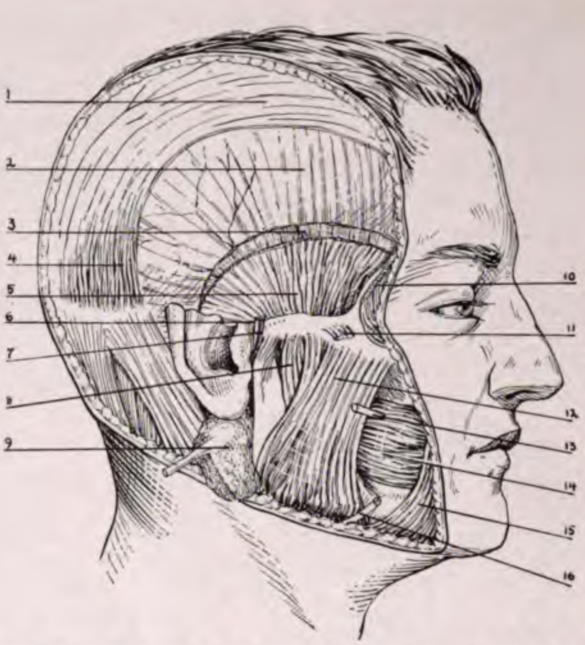


Fig. 128.—Illustrating the buccinator and masseter muscles. (Modified from Testut.)

1, Galea aponeurotica; 2, temporal fascia; 3, temporal fascia (deep layer); 4, occipitalis muscle; 5, temporal muscle; 6, auriculo-temporal artery; 7, superficial temporal artery; 8, masseter (deep fibers); 9, parotid gland (drawn backward and downward); 10, orbicularis oculi; 11, caput zygomaticum of quadratus labii superioris; 12, masseter (superficial fibers); 13, parotid duct; 14, buccinator; 15, triangularis muscle; 16, external maxillary artery.

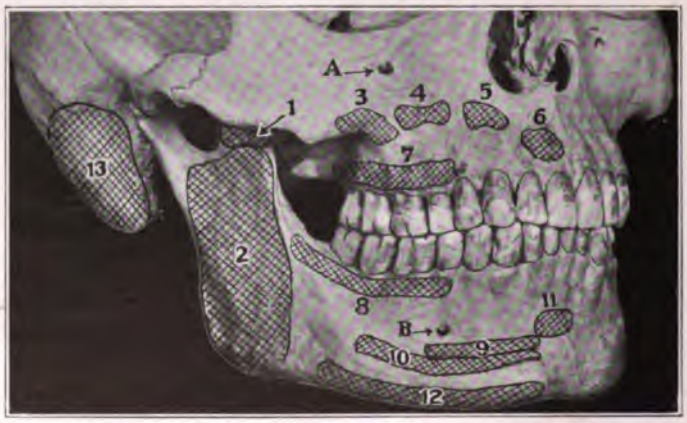


Fig. 129.—Illustrating various muscle attachments to the superior and inferior maxillary bones.

1, Insertion temporal muscle; 2, insertion masseter muscle; 3, origin (in part) masseter muscle; 4, origin levator anguli oris; 5, origin compressor nasi; 6, depressor septi; 7, origin (in part) buccinator muscle; 8, origin (in part) buccinator muscle; 9, origin depressor labii inferioris; 10, origin depressor anguli oris; 11, origin depressor menti; 12, insertion platysma myoides; 13, insertion sternomastoid; A, infraorbital foramen; B, mental foramen.

division of the fifth cranial nerve. (See Fig. 60.) This masseteric nerve is accompanied by the artery of the same name, which is a branch of the internal maxillary artery.

Action.—It elevates the lower jaw; it brings the lower teeth into occlusion with the upper teeth. The superficial portion of the muscle brings the jaw slightly anteriorly.

The Temporal Muscle. (**"The Temple Muscle."**)—*Origin.*—From the deep temporal fascia, temporal fossa and superiorly to the inferior temporal ridge of the parietal and frontal bones and as far inferiorly as the infratemporal crest located upon the greater wing of the sphenoid bone. (See Figs. 130 and 131.)

Insertion.—Into the superior and posterior borders and internal surface of the coronoid process of the mandible; also to the internal surface of the anterior border of the ascending ramus, and in some cases to a point as low as the lingual surface of the lower third molar. (See Figs. 131 and 144.) This muscle is fan-shaped.

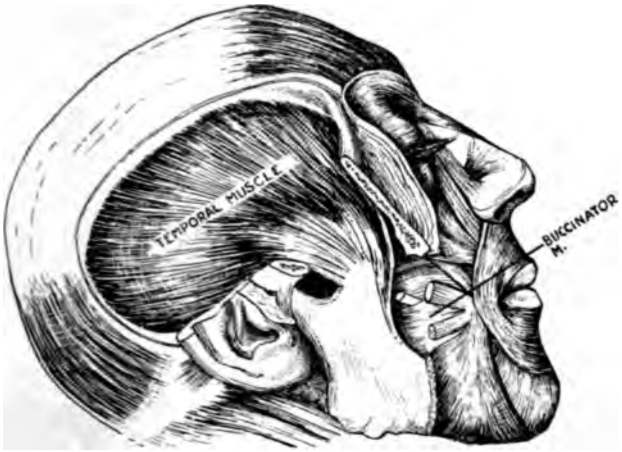


Fig. 130.—Illustrating the buccinator and temporal muscles.

Nerve and Blood Supply.—The nerve supply is from the deep temporal, which arises from the anterior portion of the third or mandibular division of the fifth cranial nerve. (See Fig. 60.) The blood supply is furnished by the temporal artery which is a branch of the internal maxillary artery. (See Fig. 123.)

Action.—Elevation of the lower jaw, and when it has been drawn anteriorly it will retract it. It acts in opposition to the external pterygoid which protracts it.

The External Pterygoid Muscle.—*Origin.*—It is situated in the zygomatic fossa. It arises by two heads: first, the upper head, from the outer surface of the great wing of the sphenoid bone; second, lower head, from the outer surface of the external pterygoid plate. This muscle assumes a direction that is backward and slightly outward. (See Figs. 132, 133, and 135.)

Insertion.—Into the anterior part of the neck of the mandible and the front of the interarticular fibrocartilage of the temporo-mandibular joint. (See Fig. 144.)

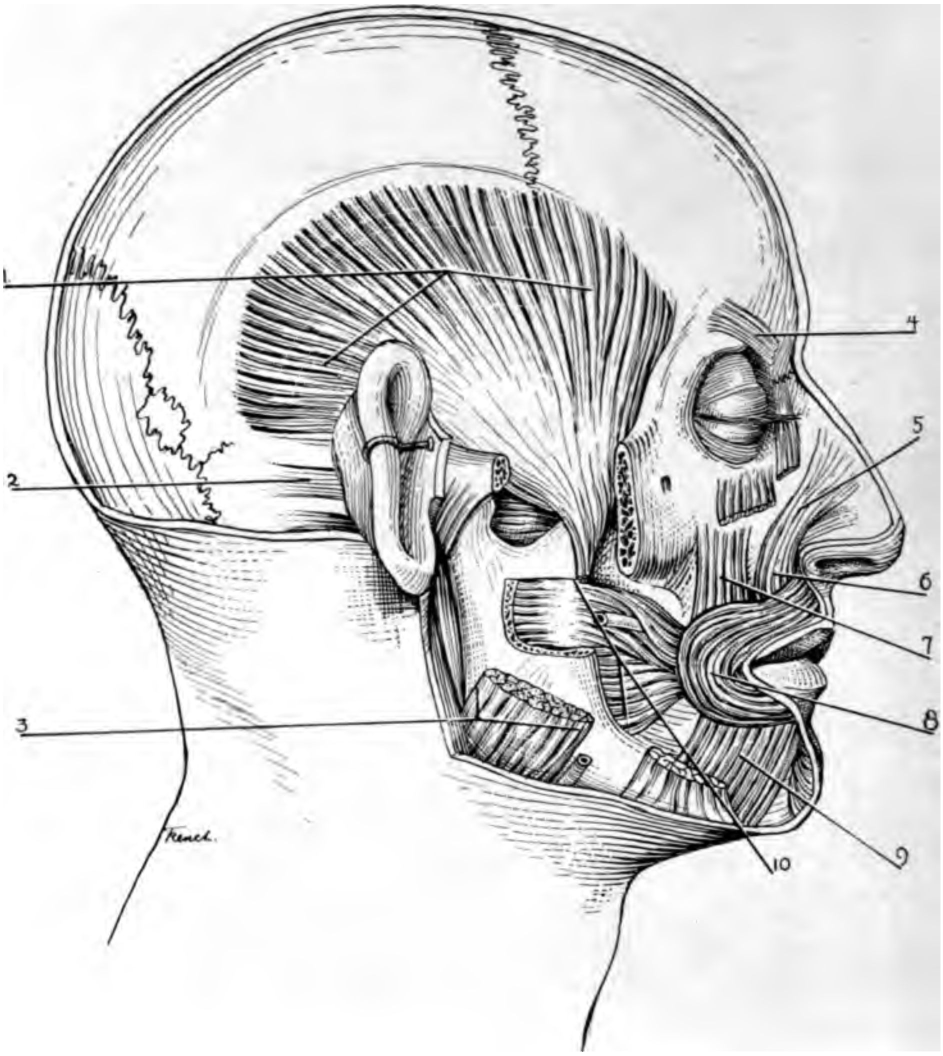


Fig. 131.—Temporal and deep muscles about the mouth. (Redrawn from Testut.)

1, Temporal muscle; 2, posterior auricular muscle; 3, masseter muscle; 4, corrugator supercilii muscle; 5, compressor narium muscle; 6, depressor muscle; 7, levator anguli oris muscle; 8, orbicularis oris muscle; 9, depressor labii inferior muscle; 10, buccinator muscle.

Nerve and Blood Supply.—Its nerve supply is through the external pterygoid branch which arises from the third or mandibular division of the fifth cranial nerve, or it may arise from the long buccal nerve. (See Fig. 60.) The d supply is from the external pterygoid branch of the internal maxillary ry. (See Fig. 123.)

Action.—It draws the condyle of the mandible and the interarticular tilage inward and forward. When the muscles of the opposite side act

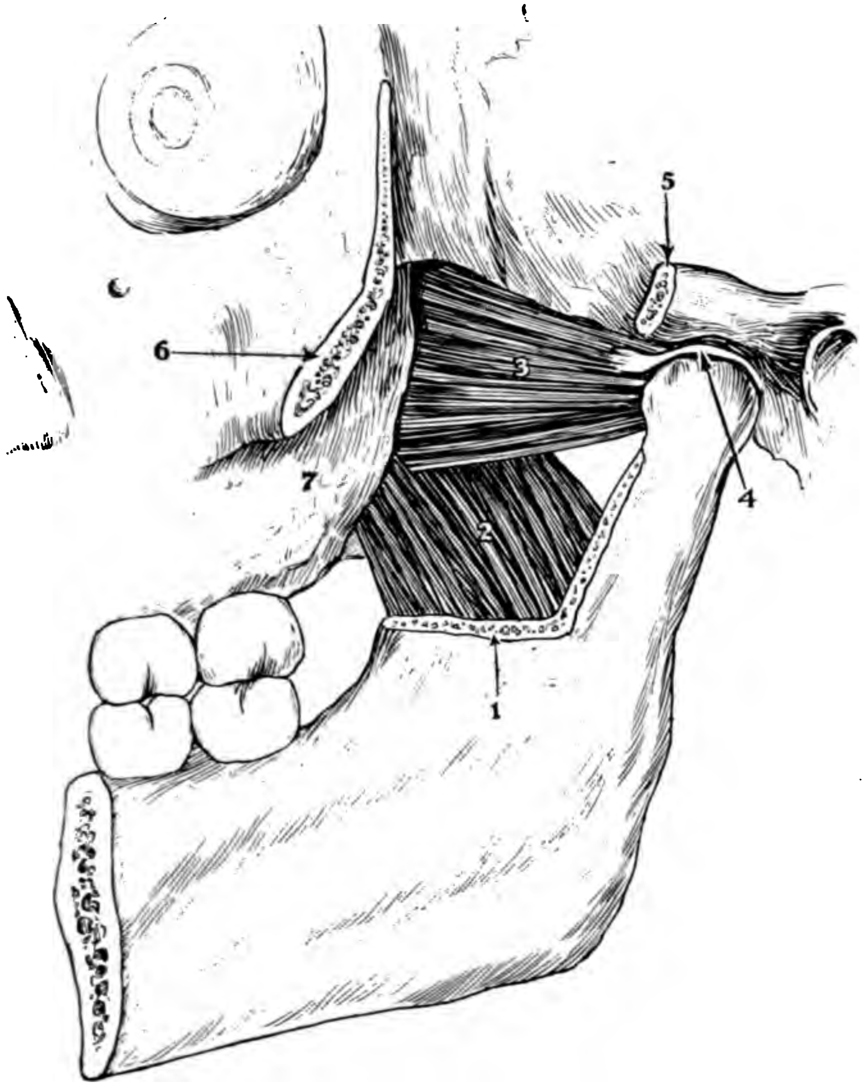


Fig. 132.—Drawing showing external and internal pterygoid muscles.

1, Section of ascending ramus; 2, internal pterygoid muscle; 3, external pterygoid muscle; 4, rarticular fibrocartilage; 5, zygomatic process; 6, zygomatic bone; 7, tuberosity of maxilla.

coordination, the mandible is protruded and the lower incisors and cuspid th protrude beyond the incisal plane of the upper teeth. However, the scles on the opposite side of the arch usually act in reciprocal succession in the oblique or "the grinding movement," the lower molars of one side being carried forward and inward upon the corresponding upper molars and vice versa. The external pterygoid also takes considerable part in opening the mouth from the fact that it draws the condyle and interarticular fibrocartilage anteriorly and against the eminentia articularis. This muscle also acts as an antagonist to the posterior part of the temporal muscle.

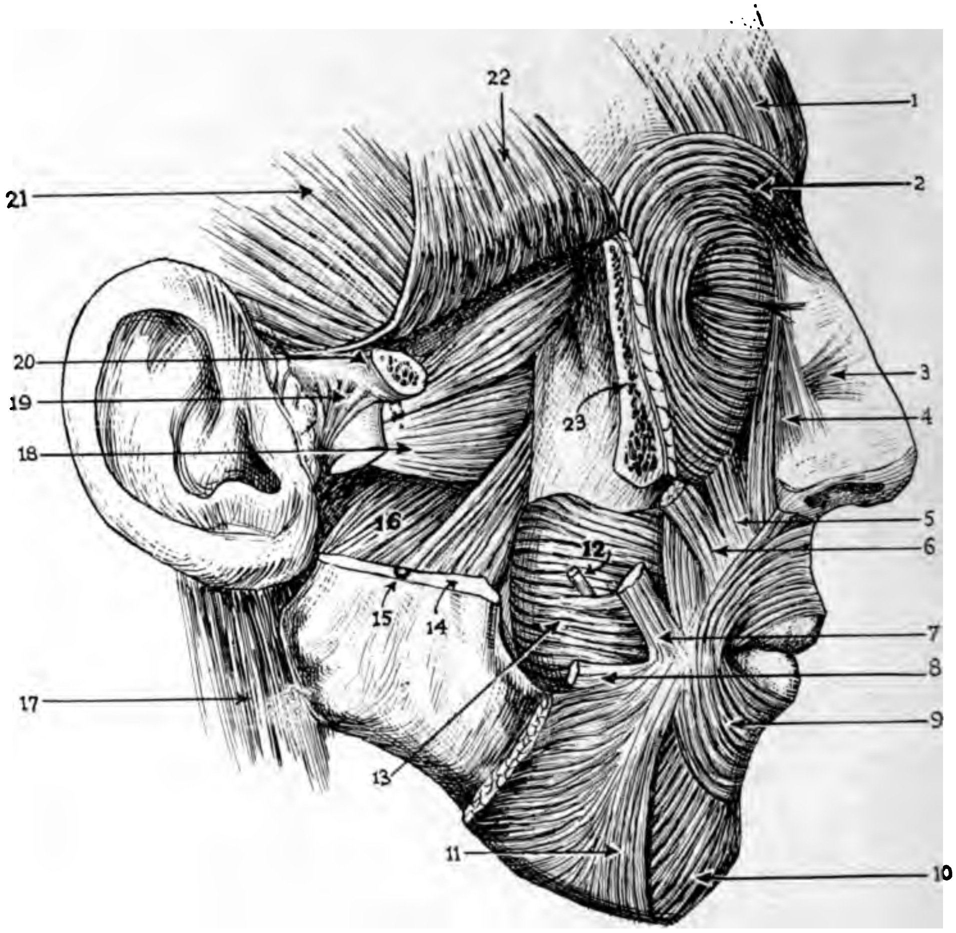


Fig. 133.—Muscles of mastication and the face. (Redrawn from Cunningham.)

1, Occipitofrontal muscle; 2, orbicularis oculi; 3, compressor nares; 4, levator labii superioris alaeque nasi; 5, levator labii superioris; 6, zygomatic minor; 7, zygomatic major; 8, risarius; 9, orbicularis oris; 10, depressor labii inferioris; 11, depressor anguli oris; 12, Stenson's duct; 13, buccinator muscle; 14, ramus; 15, inferior dental foramen; 16, internal pterygoid muscle; 17, sternomastoid muscle; 18, lower head external pterygoid; 19, condyle; 20, zygomatic arch; 21, upper head external pterygoid muscle; 22, temporal muscle; 23, zygomatic bone.

The Internal Pterygoid Muscle.—Also called the "Internal Masseter."

Origin.—From the inner surface of the external pterygoid plate of the sphenoid bone and the tuberosities of the palate and superior maxillary bones. (See Figs. 135 and 136.)

Insertion.—Into the inner aspect of the ramus of the mandible between the angle and the inferior dental foramen. The direction of this muscle is backward, downward, and outward. (See Figs. 132, 133, and 144.)

Nerve and Blood Supply.—It derives its nerve supply from the internal pterygoid branch of the anterior portion of the third or mandibular division of the fifth cranial nerve. (See Fig. 60.)

The blood supply is from the internal pterygoid branch of the internal maxillary artery. (See Fig. 123.)

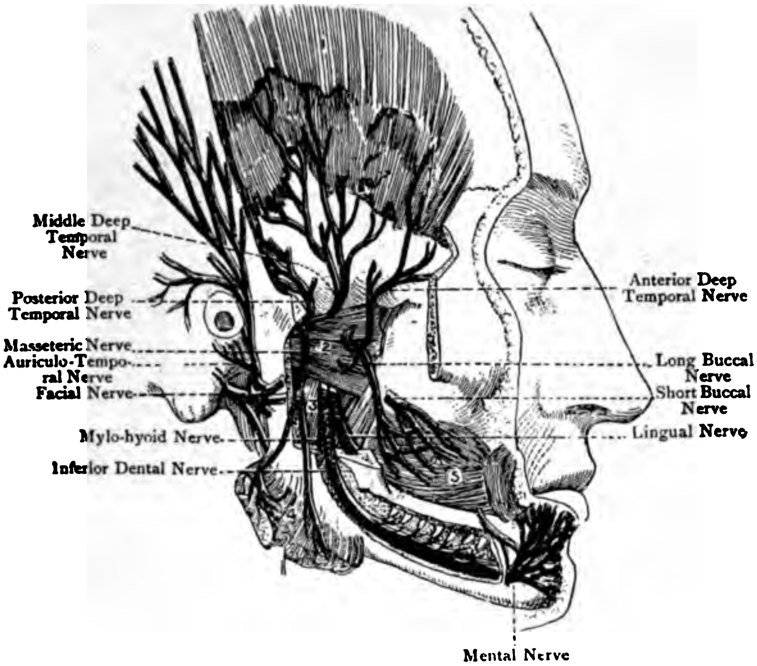


Fig. 134.—The nerves of the temporal and pterygomaxillary regions. (From Buchanan.)

1, Temporal muscle; 2, external pterygoid; 3, internal pterygoid; 4, masseter; 5, buccinator.

Action.—To elevate the lower jaw; and draws the jaw forward when the mouth is closed.

The Buccinator Muscle.—(Also called "The Trumpeter's" Muscle.) This muscle is not included as a muscle of mastication by some authors. It forms the outer wall of the mouth.

Origin.—This muscle, which is horseshoe-shaped, arises from the tuberosity of the maxilla and the outer surfaces of the alveolar borders of the superior and inferior maxillæ, opposite the first, second and third molar teeth and from the pterygomaxillary ligament. (See Figs. 129, 141, and 142.)

Insertion.—Into the orbicularis oris at the angle of the mouth and the integument of the lips. (See Figs. 133 and 139.)

Nerve Supply.—From the buccal branch of the facial or seventh nerve. It is pierced by the long buccal nerve of the fifth cranial, which sory, and also pierced by Stenson's duct. (See Figs. 60 and 141.)

Action. It draws the angle of the mouth laterally and presses tl against the teeth. This muscle prevents food from accumulating betwe lips, cheeks, and teeth, and when the cheeks are distended, this muscle to compress the contents of food against the teeth which plays an imp part in their mastication. It also regulates the expulsion of air fro oral cavity as in playing a horn or whistling.

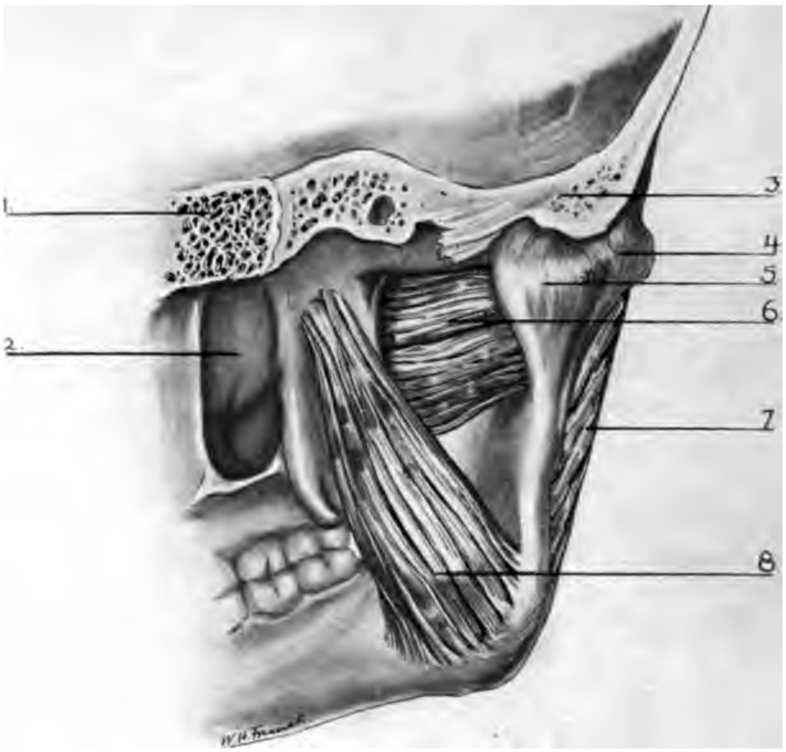


Fig. 135. External and internal pterygoid muscles. (Redrawn from Benninghofen.)

1, Occipital bone; 2, nasal cavity; 3, temporal bone; 4, zygomatic arch; 5, condyloid pro external pterygoid muscle; 7, masseter muscle; 8, internal pterygoid muscle.

Anatomy and Histology of Mucous Membrane, Gum Tissue, Peridental brane, Periosteum of Oral Cavity

Mucous Membrane. The mucous membrane of the oral cavity is throughout with stratified squamous epithelium, differing from the epith of the epidermis, in that the stratum granulosum does not appear as an pendent layer, and that the stratum lucidum is usually absent. Beneat epithelium lies the mucosa, stratum proprium, or tunica propria. Th cosa consists of interlacing bundles of connective tissue fibers, among which are many elastic fibers. On the surface, numerous papillæ present themselves, which are elevations of the mucosa, varying in length and density according to their location. At the red margin of lips and in the gums the papillæ are higher than on the cheeks, where they are low and broad, but all contain many capillaries and arterioles. Everywhere in the mucosa the ducts of mucous glands are found, whose bodies lie in the submucosa. The submucosa, or tela submucosa, is a firm connective tissue layer possessing very few elastic fibers. On the gums and hard palate the submucosa is closely connected with the periosteum, and contains numerous glands, especially at its posterior portion. The blood vessels form two plexuses more or less parallel to the surface, the deeper, which consists of larger vessels, lies in the submucosa; the upper is made up of a fine meshwork of small vessels, which are derived from the deeper layer and are situated in the mucosa. From these networks, fine branches proceed to the papillæ, where a capillary plexus is formed. The lymph vessels follow a course very similar to that of the blood vessels. The mucosa and epithelial lining are richly supplied with nerves which terminate in two ways: *First,* on the papillæ as

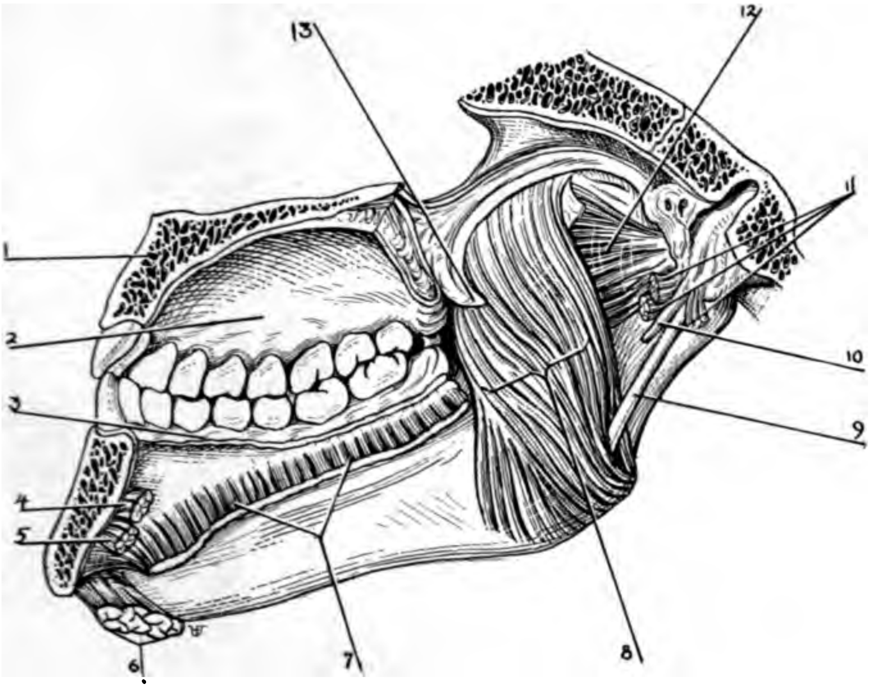


Fig. 136.—The internal pterygoid muscle. (Redrawn from Sobotta-McMurrich.)

1, Section of maxilla; 2, palatine mucous membrane; 3, oral mucous membrane; 4, genioglossal muscle; 5, geniohyoid muscle; 6, digastric muscle (anterior body); 7, mylohyoid muscle; 8, internal pterygoid; 9, stylomandibular ligament; 10, styloid process; 11, stylohyoid, stylopharyngeal, and styloglossal; 12, external pterygoid; 13, hamular process.

Krause's end bulbs; and, *second*, in the epithelium as fine intraepithelial nerve endings.

Gum Tissue.—The mucous membrane of the lips is continuous with that covering the fibrous tissue of the gums. The gums have long and attenuated papillæ, covered by a very thin layer of epithelium, below which are the capillary plexuses contained in each papilla, which accounts for the free bleeding of the gums on the slightest injury. The insertion of the needle for making deep block injections is not made in the gum tissue, because of its more fibrous construction and greater nerve and blood supply over that of the mucous membrane, which is easily pierced with little or no pain, if a needle with the proper point and bevel is used.

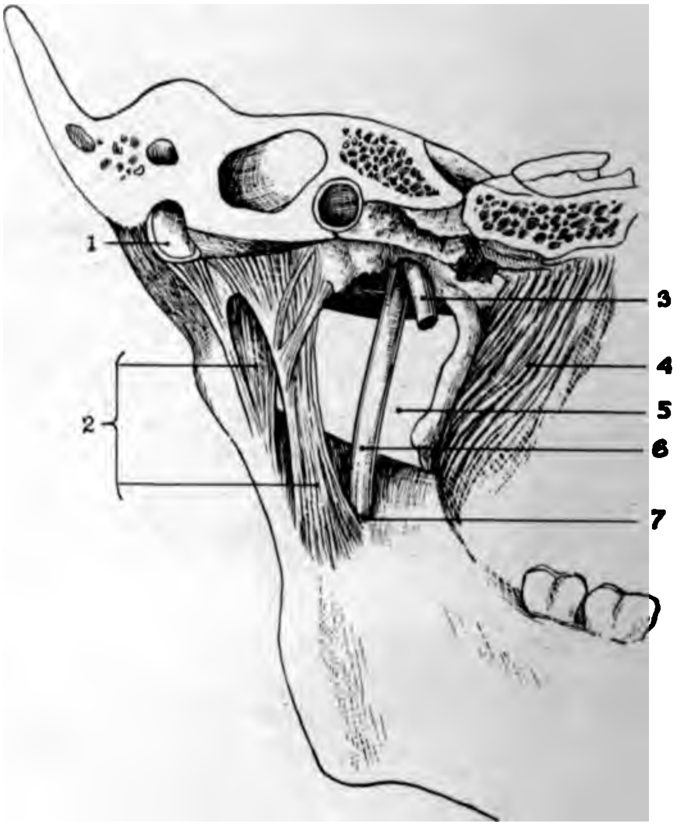


Fig. 137.

1. External auditory meatus; 2, sphenomandibular ligament; 3, lingual nerve; 4, internal pterygoid muscle; 5, external pterygoid muscle; 6, mandibular nerve; 7, mandibular foramen. (Redrawn and modified from Henle.)

Peridental Membrane.—The tooth is attached to the alveolus by a fibrous tissue membrane, which is really the periosteum of the alveolus and cementum of the tooth. It consists of bundles of connective tissue, directly continuous with Sharpey's fibers in the cementum and the alveolus. Between these coarse bundles of fibers which have a direction nearly horizontal with the upper portions of the membrane, and incline toward the lower end of the tooth in its lower portion, there is found less dense connective tissue which is richly supplied with nerve fibers and blood vessels. Owing to the hypersensitiveness of the peridental membrane, it is much more uncomfortable to the patient when the operator employs peridental anesthesia than inserting the needle into less sensitive tissue which is the case in block anesthesia.

Mucous Membrane of Tongue.—The mucous membrane of the tongue differs slightly from that lining the rest of the oral cavity. In the greater part of the tongue the submucosa is poorly developed, and as a consequence the mucous membrane on the upper surface of the tongue is scarcely movable. Other peculiarities are the absence of glands in the mucosa on the upper surface of the tongue; although glands are found in the musculature of the tongue, their ducts pass through the mucosa. There is little or no difference in the texture of the mucous membrane lining the floor of the mouth, cheeks, gums and lips.

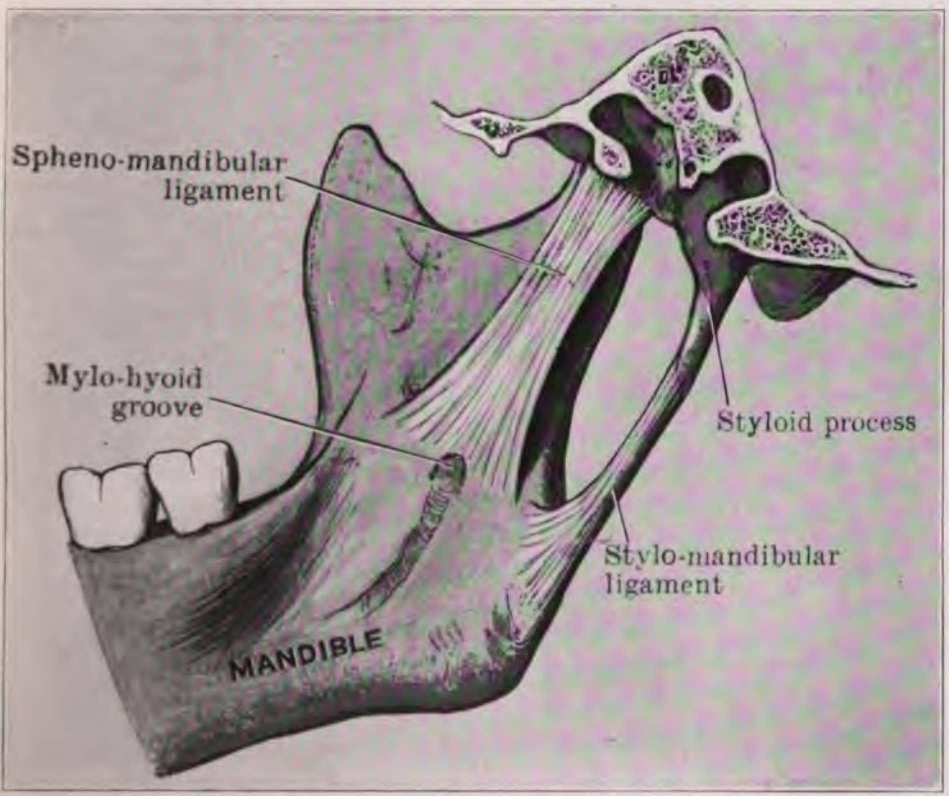


Fig. 138.—Illustrating the sphenomandibular ligament. (Retouched from Cunningham.)

Mucous Membrane in Block Anesthesia.—The object of discussing the anatomy and histology of the mucous membrane is that practically all in-

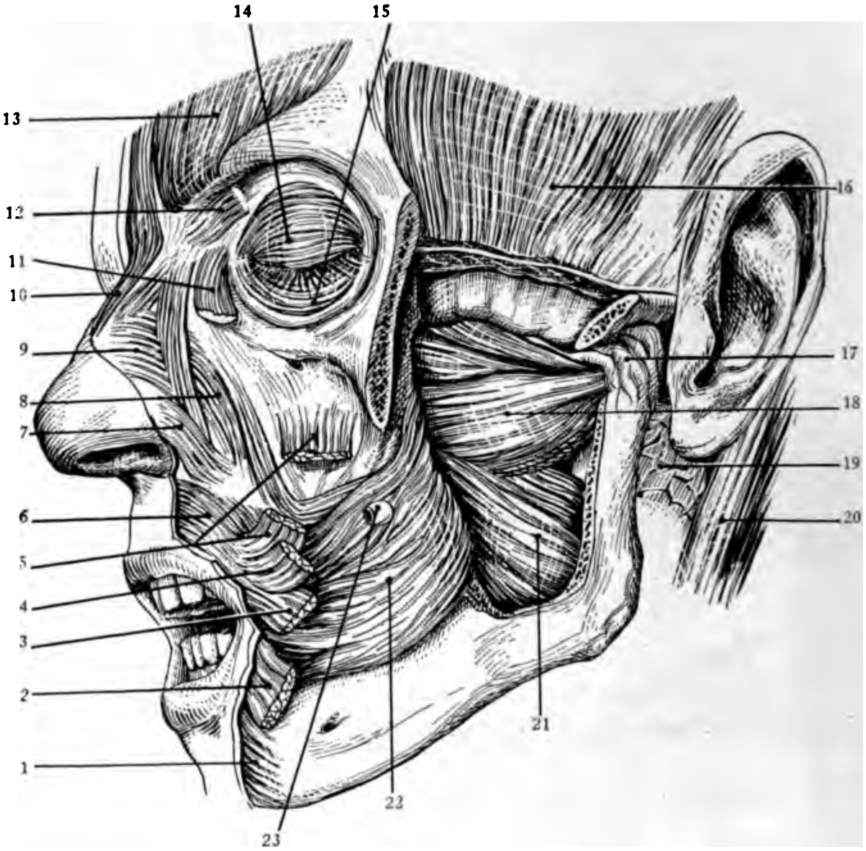


Fig. 139.—Deep layers of the facial muscles; the buccinator and pterygoid seen from the side. (Redrawn and modified from Sobotta-McMurrich.)

1, Mentalis; 2, quadratus labii inf.; 3, triangularis; 4, zygomaticus; 5, caninus; 6, orbicularis oris; 7, alar port.; 8, transverse port.; 9, nasalis; 10, procerus; 11, angular head of quadratus labii super.; 12, corrugator supercilii; 13, frontalis; 14, orbicularis oculi; 15, palpebral port.; 16, temporalis; 17, articular capsule; 18, pterygoideus externus; 19, parotid gland; 20, sternocleidomastoid; 21, pterygoideus internus; 22, buccinator; 23, parotid duct.

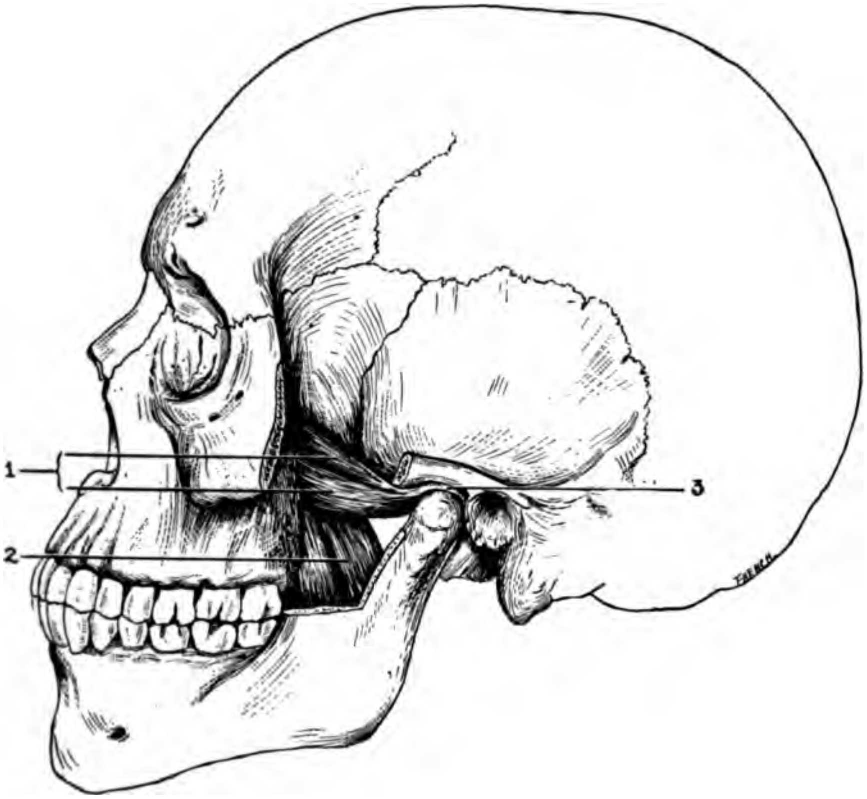


Fig. 140.—(Pen drawing.) Illustrating the internal and external pterygoid muscles. 1, External pterygoid muscle; 2, internal pterygoid muscle; 3, interarticular fibrocartilage.

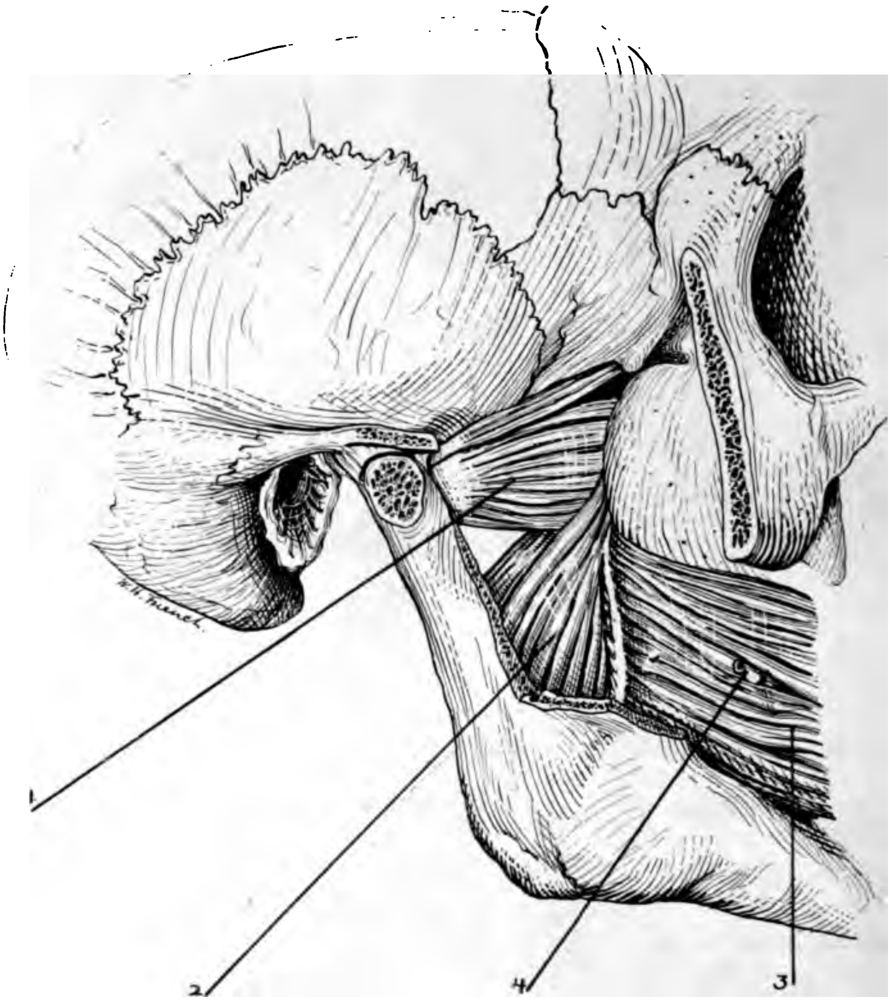


Fig. 141.—Drawing showing pterygoid and buccinator muscles. (Redrawn from Benninghofen.) 1, External pterygoid muscle; 2, internal pterygoid muscle; 3, buccinator muscle; 4, Wharton's duct.

traoral block injections are made by inserting the needle into this kind of tissue. This is due mainly to its soft, elastic texture, which is not as richly supplied with nerves as the gum tissue, and may be easily pierced with a sharp needle of the proper bevel. All nerve branches are reached with greater ease through the mucous membrane, which eliminates the difficulties that would arise if the needle was inserted into the gum tissue, and an attempt made to reach the nerve branch by following the periosteum. In injecting the solution too quickly into the soft mucous membrane care must be taken to avoid expansion or ballooning of the tissue, which would result in discomfort and postoperative soreness.

Periosteum.—The external surface of bones is closely invested, except where covered with cartilage, with a fibrous membrane called the periosteum, which is of great importance during development and growth, and later for the nutrition and protection of osseous tissue. The adult periosteum consists of two layers, an outer fibrous and inner fibroelastic layer. When covering young bones, in which growth is actively progressing, it contains an additional stratum, the osteogenic layer, which lies closely associated with the exterior of the bone. After growth this becomes included in the fibroelastic constituent of the periosteum. The fibrous layer is composed of closely placed bundles of fibrous connective tissue, and serves to support the larger blood vessels, which break up within the deeper parts of the periosteum to supply the bone. The fibroelastic layer consists of a rich felt-work of elastic fibers, often arranged as several distinct strata. The elastic tissue is separated from the bone by a layer of fibrous tissue. The inner surface of the periosteum is intimately attached to the osseous tissue by means of delicate processes of connective tissue. The fibrous layer of the periosteum is tough, but may be pierced by a needle in block anesthesia, if great care is

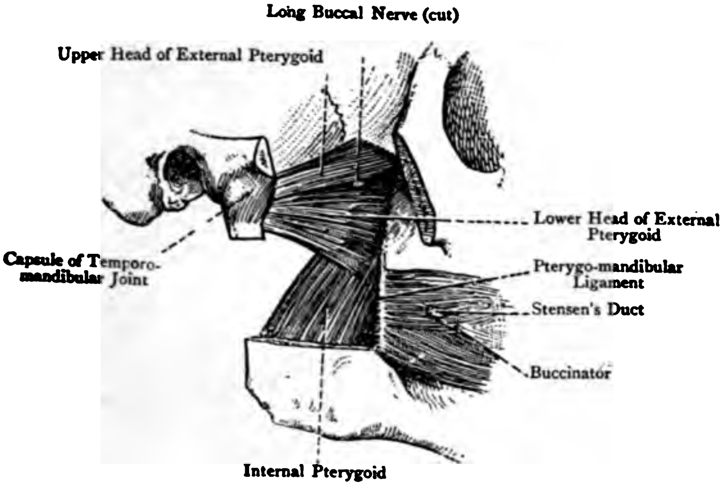

Long Buccal Nerve (cut)
Upper Head of External Pterygoid
Lower Head of External Pterygoid
Capsule of Temporo-mandibular Joint
Pterygo-mandibular Ligament
Stensen's Duct
Buccinator
Internal Pterygoid

Fig. 142.—The pterygoid and buccinator muscles. (From Buchanan.)

outer surface of the external pterygoid plate. This muscle assumes a direction that is backward and slightly outward. (See Figs. 132, 133, and 135.)

Insertion.—Into the anterior part of the neck of the mandible and the front of the interarticular fibrocartilage of the temporo-mandibular joint. (See Fig. 144.)

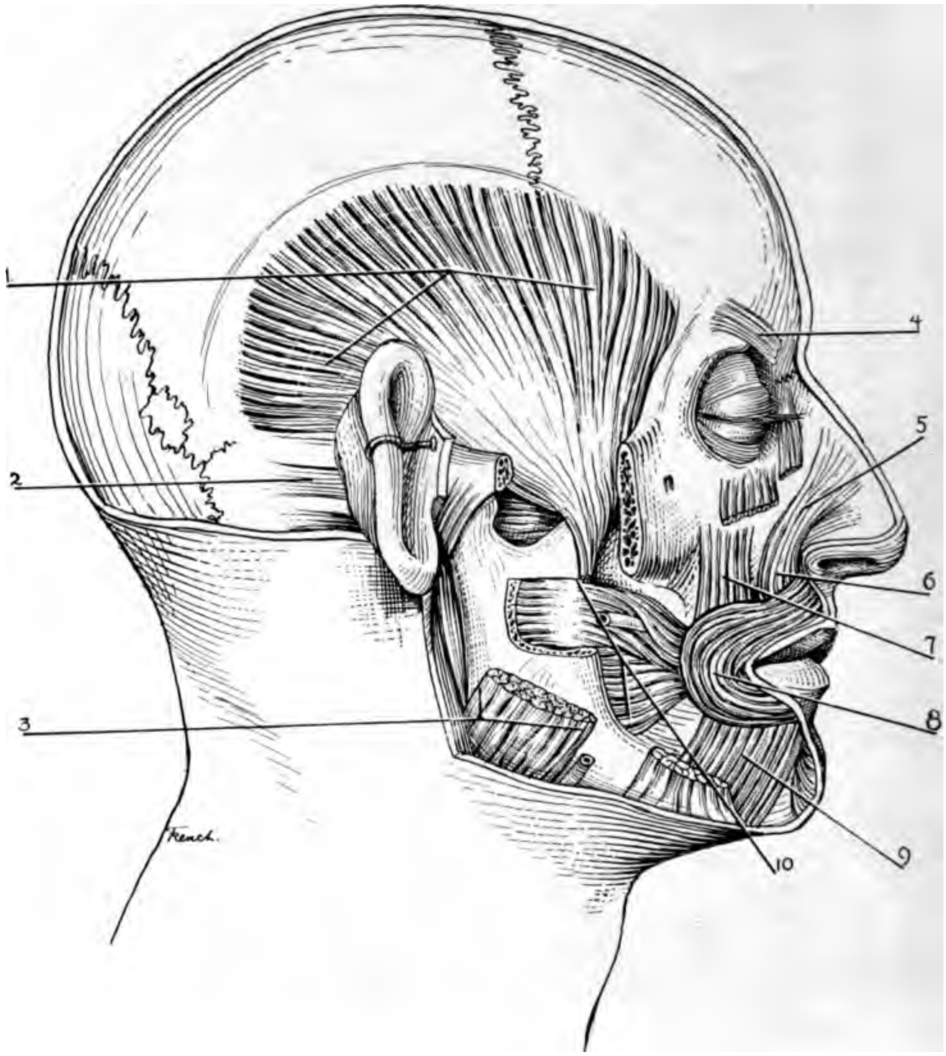


Fig. 131.—Temporal and deep muscles about the mouth. (Redrawn from Testut.)

1, Temporal muscle; 2, posterior auricular muscle; 3, masseter muscle; 4, corrugator supercilii muscle; 5, compressor narium muscle; 6, depressor muscle; 7, levator anguli oris muscle; 8, orbicularis oris muscle; 9, depressor labii inferior muscle; 10, buccinator muscle.

Nerve and Blood Supply.—Its nerve supply is through the external pterygoid branch which arises from the third or mandibular division of the fifth cranial nerve, or it may arise from the long buccal nerve. (See Fig. 60.) The blood supply is from the external pterygoid branch of the internal maxillary artery. (See Fig. 123.)

Action.—It draws the condyle of the mandible and the interarticular cartilage inward and forward. When the muscles of the opposite side act in coordination, the mandible is protruded and the lower incisors and cuspid teeth protrude beyond the incisal plane of the upper teeth. However, the muscles on the opposite side of the arch usually act in reciprocal succession as in the oblique or "the grinding movement," the lower molars of one side

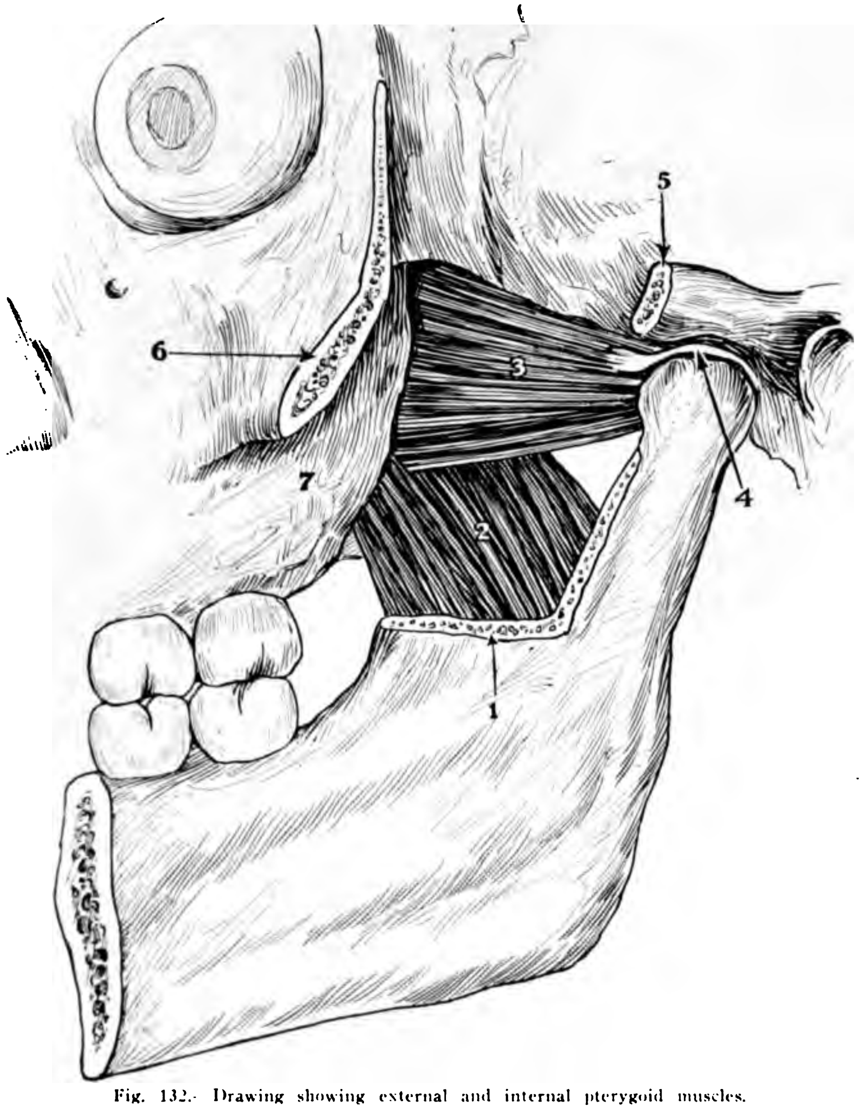


Fig. 132.- Drawing showing external and internal pterygoid muscles.

1, Section of ascending ramus; 2, internal pterygoid muscle; 3, external pterygoid muscle; 4, interarticular fibrocartilage; 5, zygomatic process; 6, zygomatic bone; 7, tuberosity of maxilla.

being carried forward and inward upon the corresponding upper molars and vice versa. The external pterygoid also takes considerable part in opening the mouth from the fact that it draws the condyle and interarticular fibrocartilage anteriorly and against the eminentia articularis. This muscle also acts as an antagonist to the posterior part of the temporal muscle.

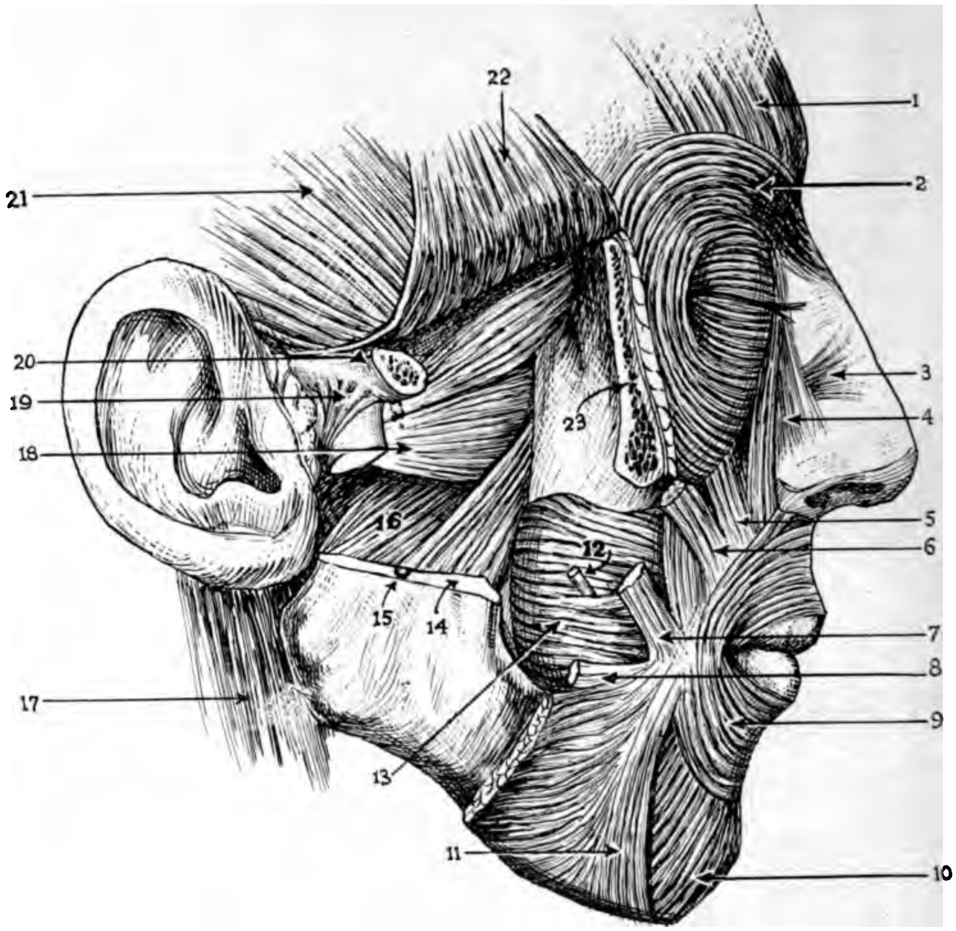


Fig. 133.—Muscles of mastication and the face. (Redrawn from Cunningham.)

1, Occipitofrontal muscle; 2, orbicularis oculi; 3, compressor nares; 4, levator labii superioris alaeque nasi; 5, levator labii superioris; 6, zygomatic minor; 7, zygomatic major; 8, risarius; 9, orbicularis oris; 10, depressor labii inferioris; 11, depressor anguli oris; 12, Stenson's duct; 13, buccinator muscle; 14, ramus; 15, inferior dental foramen; 16, internal pterygoid muscle; 17, sternomastoid muscle; 18, lower head external pterygoid; 19, condyle; 20, zygomatic arch; 21, upper head external pterygoid muscle; 22, temporal muscle; 23, zygomatic bone.

The Internal Pterygoid Muscle.—Also called the "Internal Masseter."

Origin.—From the inner surface of the external pterygoid plate of the sphenoid bone and the tuberosities of the palate and superior maxillary bones. (See Figs. 135 and 136.)

Insertion.—Into the inner aspect of the ramus of the mandible between the angle and the inferior dental foramen. The direction of this muscle is backward, downward, and outward. (See Figs. 132, 133, and 144.)

Nerve and Blood Supply.—It derives its nerve supply from the internal pterygoid branch of the anterior portion of the third or mandibular division of the fifth cranial nerve. (See Fig. 60.)

The blood supply is from the internal pterygoid branch of the internal maxillary artery. (See Fig. 123.)

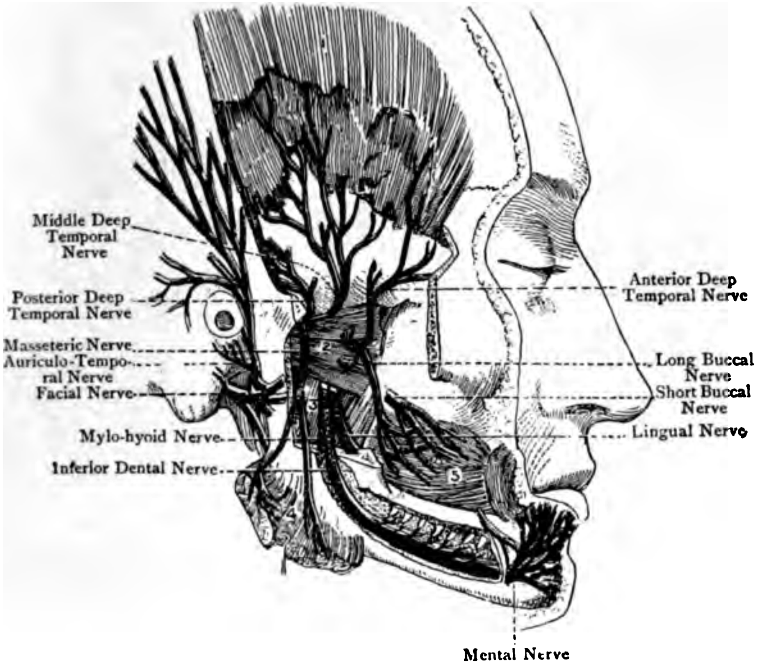


Fig. 134.—The nerves of the temporal and pterygomaxillary regions. (From Buchanan.)

1, Temporal muscle; 2, external pterygoid; 3, internal pterygoid; 4, masseter; 5, buccinator.

Action.—To elevate the lower jaw; and draws the jaw forward when the mouth is closed.

The Buccinator Muscle.—(Also called "The Trumpeter's" Muscle.) This muscle is not included as a muscle of mastication by some authors. It forms the outer wall of the mouth.

Origin.—This muscle, which is horseshoe-shaped, arises from the tuberosity of the maxilla and the outer surfaces of the alveolar borders of the superior and inferior maxillæ, opposite the first, second and third molar teeth and from the pterygomaxillary ligament. (See Figs. 129, 141, and 142.)

Insertion.—Into the orbicularis oris at the angle of the mouth and the integument of the lips. (See Figs. 133 and 139.)

Nerve Supply.—From the buccal branch of the facial or seventh cranial nerve. It is pierced by the long buccal nerve of the fifth cranial, which is sensory, and also pierced by Stenson's duct. (See Figs. 60 and 141.)

Action.—It draws the angle of the mouth laterally and presses the lips against the teeth. This muscle prevents food from accumulating between the lips, cheeks, and teeth, and when the cheeks are distended, this muscle serves to compress the contents of food against the teeth which plays an important part in their mastication. It also regulates the expulsion of air from the oral cavity as in playing a horn or whistling.

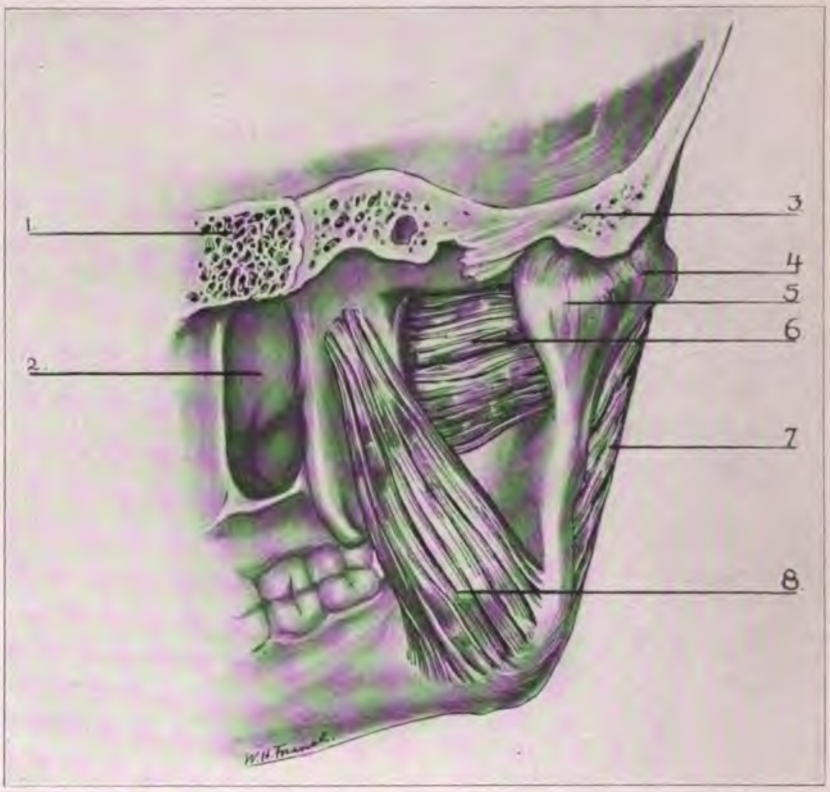


Fig. 135.—External and internal pterygoid muscles. (Redrawn from Benninghofen.)

1, Occipital bone; 2, nasal cavity; 3, temporal bone; 4, zygomatic arch; 5, condyloid process; 6, external pterygoid muscle; 7, masseter muscle; 8, internal pterygoid muscle.

Anatomy and Histology of Mucous Membrane, Gum Tissue, Peridental Membrane, Periosteum of Oral Cavity

Mucous Membrane.—The mucous membrane of the oral cavity is lined throughout with stratified squamous epithelium, differing from the epithelium of the epidermis, in that the stratum granulosum does not appear as an independent layer, and that the stratum lucidum is usually absent. Beneath the epithelium lies the mucosa, stratum proprium, or tunica propria. The mucosa consists of interlacing bundles of connective tissue fibers, among which are many elastic fibers. On the surface, numerous papillæ present themselves, which are elevations of the mucosa, varying in length and density according to their location. At the red margin of lips and in the gums the papillæ are higher than on the cheeks, where they are low and broad, but all contain many capillaries and arterioles. Everywhere in the mucosa the ducts of mucous glands are found, whose bodies lie in the submucosa. The submucosa, or tela submucosa, is a firm connective tissue layer possessing very few elastic fibers. On the gums and hard palate the submucosa is closely connected with the periosteum, and contains numerous glands, especially at its posterior portion. The blood vessels form two plexuses more or less parallel to the surface, the deeper, which consists of larger vessels, lies in the submucosa; the upper is made up of a fine meshwork of small vessels, which are derived from the deeper layer and are situated in the mucosa. From these networks, fine branches proceed to the papillæ, where a capillary plexus is formed. The lymph vessels follow a course very similar to that of the blood vessels. The mucosa and epithelial lining are richly supplied with nerves which terminate in two ways: *First,* on the papillæ as

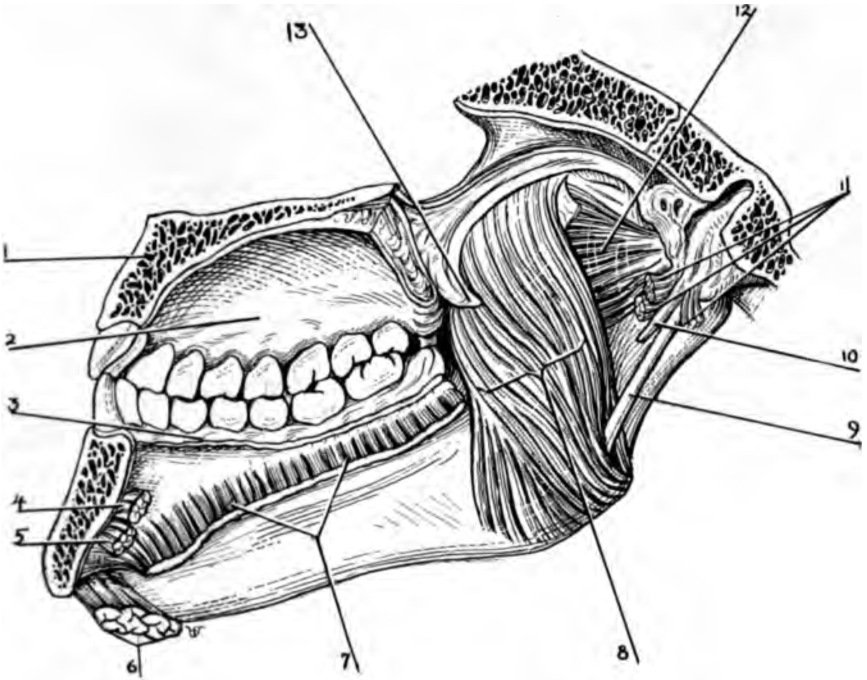


Fig. 136.—The internal pterygoid muscle. (Redrawn from Sobotta-McMurrich.)

1, Section of maxilla; 2, palatine mucous membrane; 3, oral mucous membrane; 4, genioglossal muscle; 5, geniohyoid muscle; 6, digastric muscle (anterior body); 7, mylohyoid muscle; 8, internal pterygoid; 9, stylomandibular ligament; 10, styloid process; 11, stylohyoid, stylopharyngeal, and styloglossal; 12, external pterygoid; 13, hamular process.

Krause's end bulbs; and, *second,* in the epithelium as fine intraepithelial nerve endings.

Gum Tissue.—The mucous membrane of the lips is continuous with that covering the fibrous tissue of the gums. The gums have long and attenuated papillæ, covered by a very thin layer of epithelium, below which are the capillary plexuses contained in each papilla, which accounts for the free bleeding of the gums on the slightest injury. The insertion of the needle for making deep block injections is not made in the gum tissue, because of its more fibrous construction and greater nerve and blood supply over that of the mucous membrane, which is easily pierced with little or no pain, if a needle with the proper point and bevel is used.

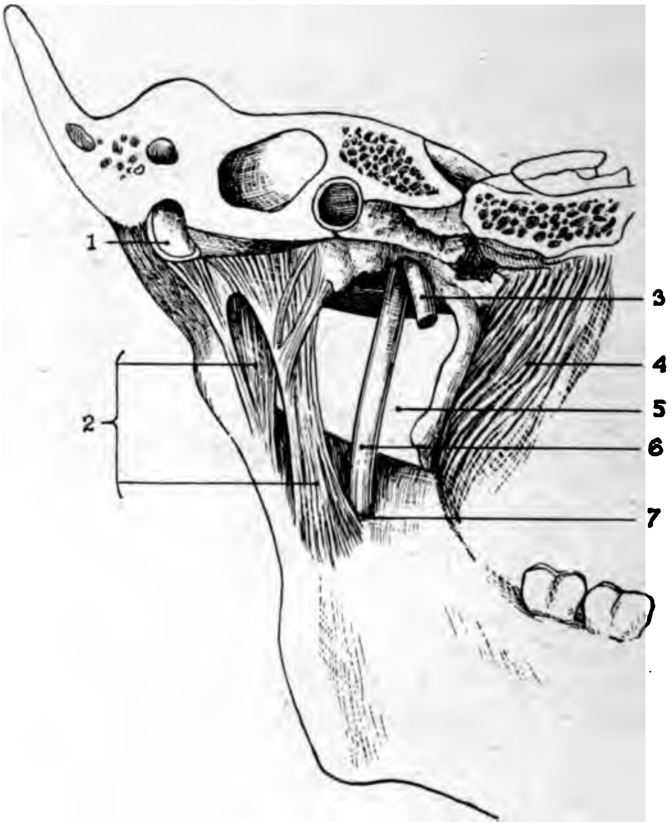


Fig. 137.

1, External auditory meatus; 2, sphenomandibular ligament; 3, lingual nerve; 4, internal pterygoid muscle; 5, external pterygoid muscle; 6, mandibular nerve; 7, mandibular foramen. (Redrawn and modified from Henle.)

Peridental Membrane.—The tooth is attached to the alveolus by a fibrous tissue membrane, which is really the periosteum of the alveolus and cementum of the tooth. It consists of bundles of connective tissue, directly continuous with Sharpey's fibers in the cementum and the alveolus. Between these coarse bundles of fibers which have a direction nearly horizontal with the upper portions of the membrane, and incline toward the lower end of the tooth in its lower portion, there is found less dense connective tissue which is richly supplied with nerve fibers and blood vessels. Owing to the hypersensitiveness of the peridental membrane, it is much more uncomfortable to the patient when the operator employs peridental anesthesia than inserting the needle into less sensitive tissue which is the case in block anesthesia.

Mucous Membrane of Tongue.—The mucous membrane of the tongue differs slightly from that lining the rest of the oral cavity. In the greater part of the tongue the submucosa is poorly developed, and as a consequence the mucous membrane on the upper surface of the tongue is scarcely movable. Other peculiarities are the absence of glands in the mucosa on the upper surface of the tongue; although glands are found in the musculature of the tongue, their ducts pass through the mucosa. There is little or no difference in the texture of the mucous membrane lining the floor of the mouth, cheeks, gums and lips.

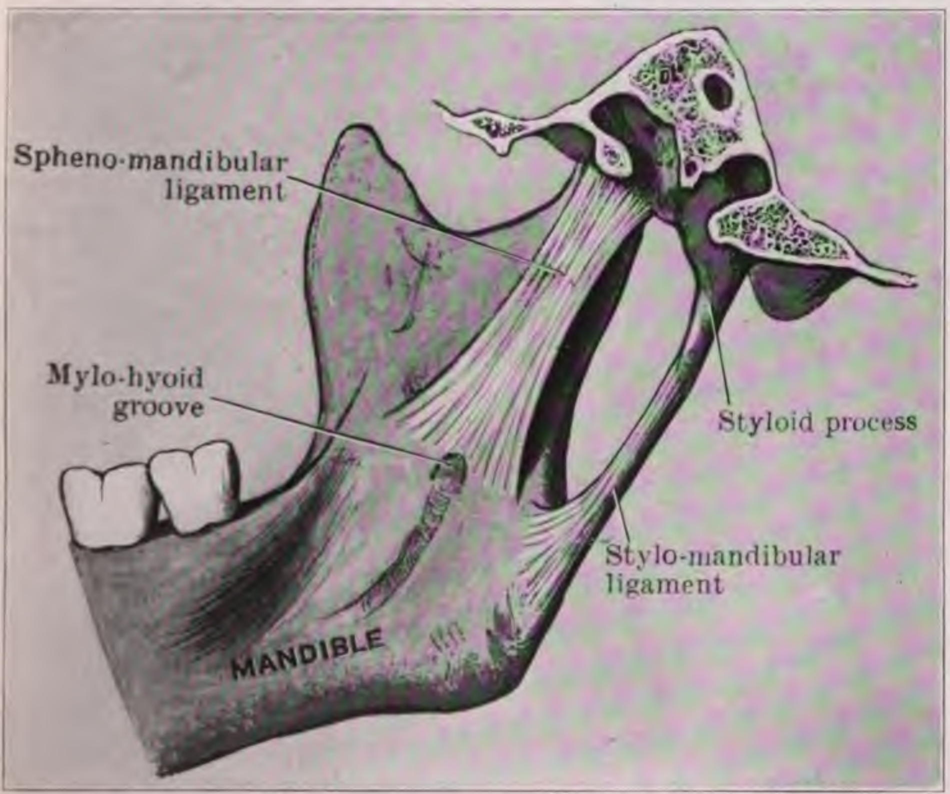


Fig. 138.—Illustrating the sphenomandibular ligament. (Retouched from Cunningham.)

Mucous Membrane in Block Anesthesia.—The object of discussing the anatomy and histology of the mucous membrane is that practically all in-

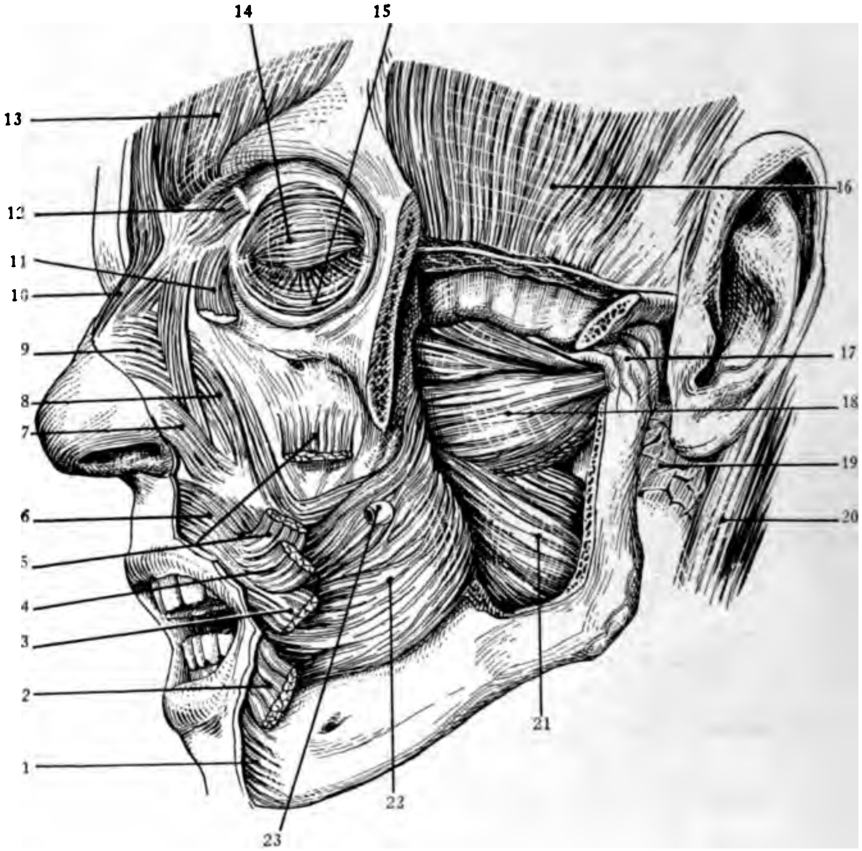


Fig. 139.—Deep layers of the facial muscles; the buccinator and pterygoid seen from the side. **(Redrawn and modified from Sobotta-McMurrich.)**

1, Mentalis; 2, quadratus labii inf.; 3, triangularis; 4, zygomaticus; 5, caninus; 6, orbicularis **oris;** 7, alar port.; 8, transverse port.; 9, nasalis; 10, procerus; 11, angular head of quadratus labii **super.; 12,** corrugator supercilii; 13, frontalis; 14, orbicularis oculi; 15, palpebral port.; 16, temporalis; 17, **articular** capsule; 18, pterygoideus externus; 19, parotid gland; 20, sternocleidomastoid; 21, pterygoideus **internus;** 22, buccinator; 23, parotid duct.

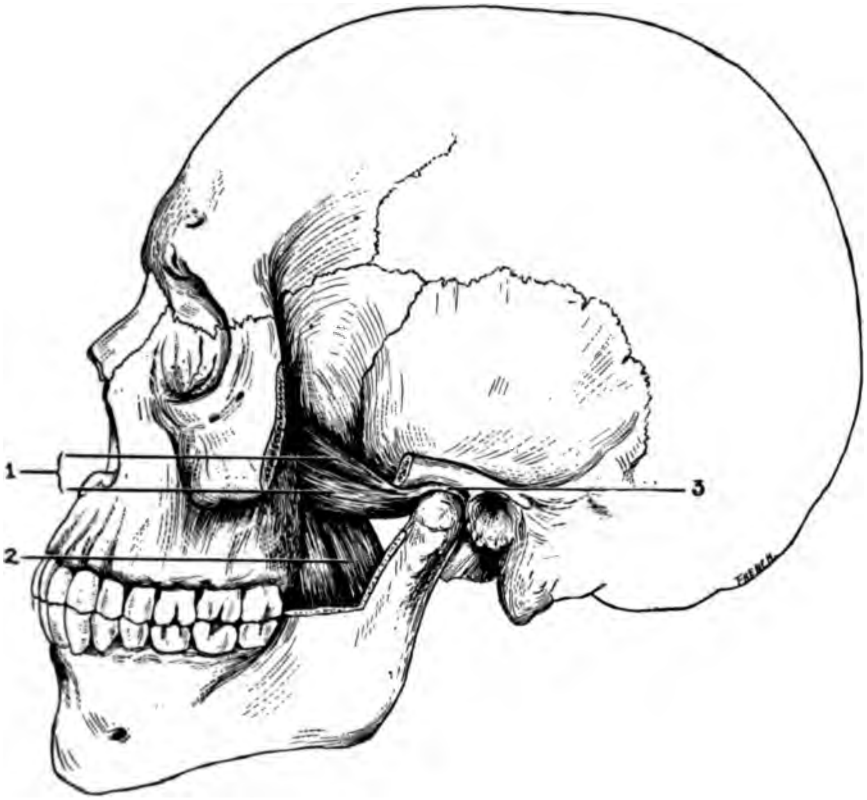


Fig. 140.—(Pen drawing.) Illustrating the internal and external pterygoid muscles. 1, External pterygoid muscle; 2, internal pterygoid muscle; 3, interarticular fibrocartilage.

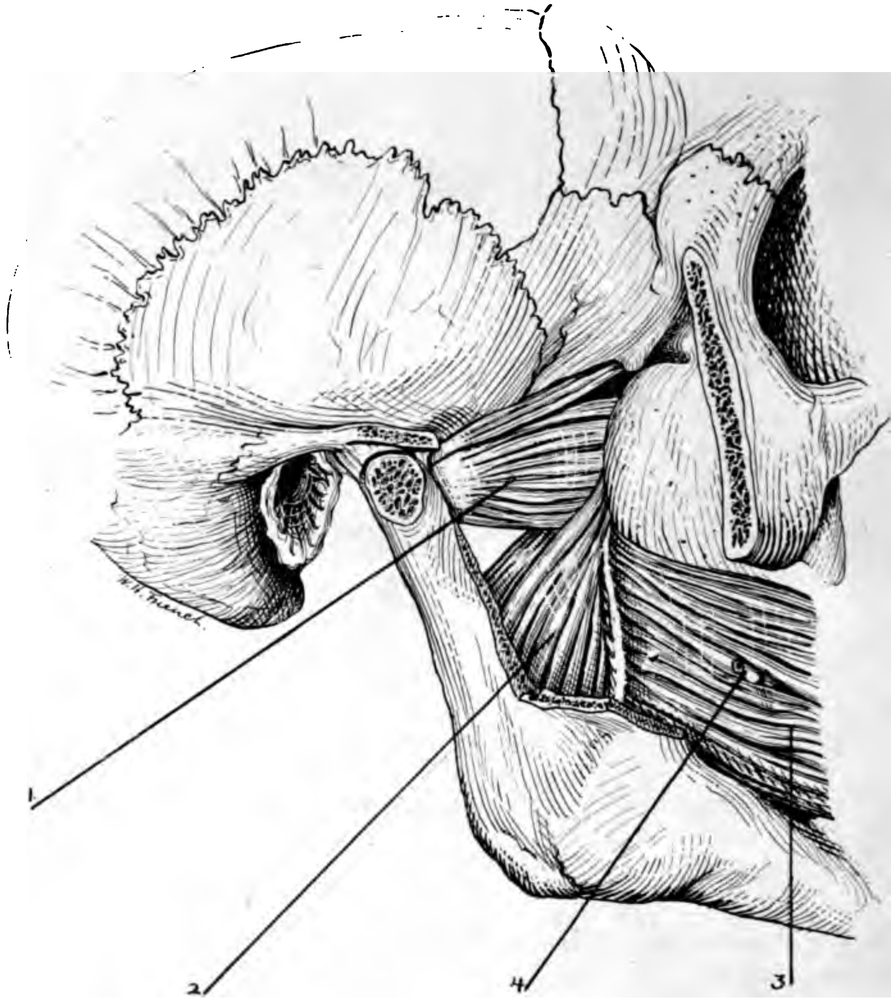


Fig. 141.—Drawing showing pterygoid and buccinator muscles. (Redrawn from Benninghofen.) 1, External pterygoid muscle; 2, internal pterygoid muscle; 3, buccinator muscle; 4, Wharton's duct.

traoral block injections are made by inserting the needle into this kind of tissue. This is due mainly to its soft, elastic texture, which is not as richly supplied with nerves as the gum tissue, and may be easily pierced with a sharp needle of the proper bevel. All nerve branches are reached with greater ease through the mucous membrane, which eliminates the difficulties that would arise if the needle was inserted into the gum tissue, and an attempt made to reach the nerve branch by following the periosteum. In injecting the solution too quickly into the soft mucous membrane care must be taken to avoid expansion or ballooning of the tissue, which would result in discomfort and postoperative soreness.

Periosteum.—The external surface of bones is closely invested, except where covered with cartilage, with a fibrous membrane called the periosteum, which is of great importance during development and growth, and later for the nutrition and protection of osseous tissue. The adult periosteum consists of two layers, an outer fibrous and inner fibroelastic layer. When covering young bones, in which growth is actively progressing, it contains an additional stratum, the osteogenic layer, which lies closely associated with the exterior of the bone. After growth this becomes included in the fibroelastic constituent of the periosteum. The fibrous layer is composed of closely placed bundles of fibrous connective tissue, and serves to support the larger blood vessels, which break up within the deeper parts of the periosteum to supply the bone. The fibroelastic layer consists of a rich felt-work of elastic fibers, often arranged as several distinct strata. The elastic tissue is separated from the bone by a layer of fibrous tissue. The inner surface of the periosteum is intimately attached to the osseous tissue by means of delicate processes of connective tissue. The fibrous layer of the periosteum is tough, but may be pierced by a needle in block anesthesia, if great care is

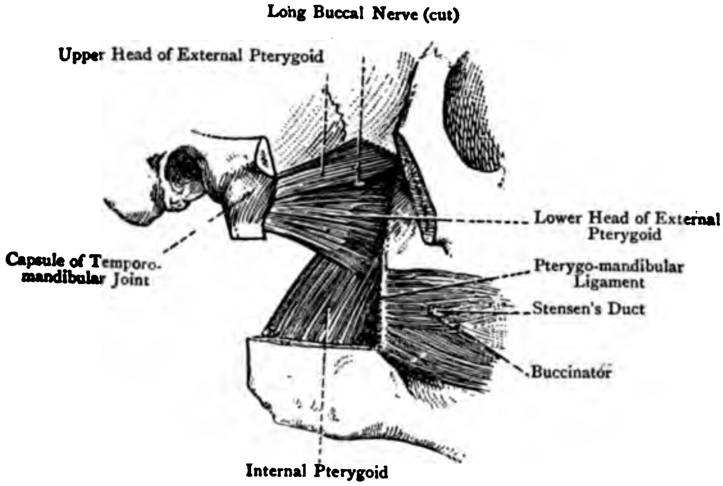

Long Buccal Nerve (cut)
Upper Head of External Pterygoid
Capsule of Temporo-mandibular Joint
Lower Head of External Pterygoid
Pterygo-mandibular Ligament
Stensen's Duct
Buccinator
Internal Pterygoid

Fig. 142.—The pterygoid and buccinator muscles. (From Buchanan.)

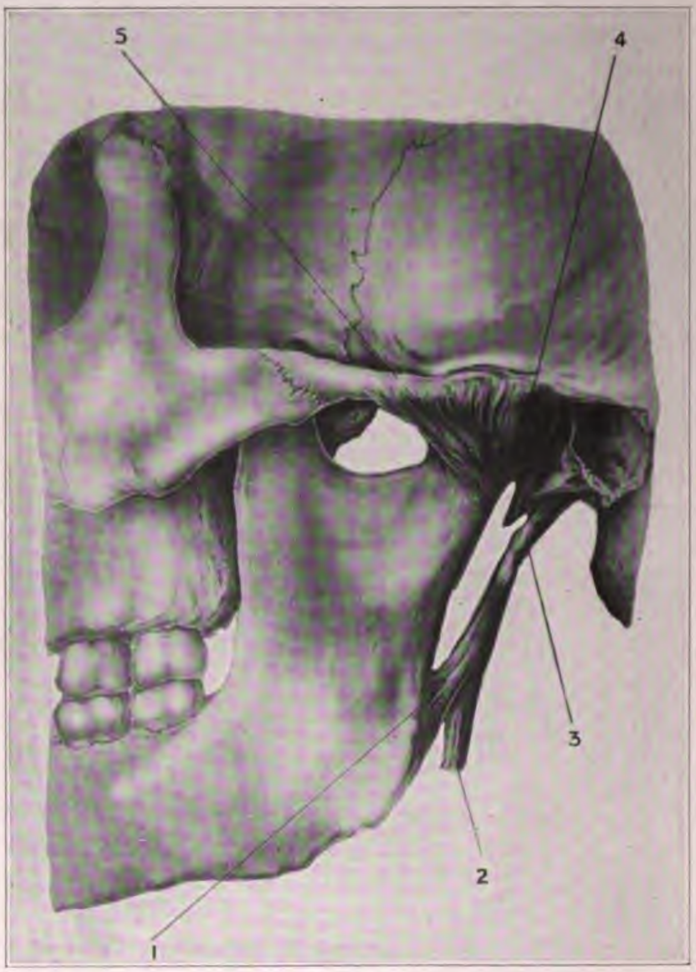


Fig. 143.

1, Stylomandibular ligament; 2, stylohyoid ligament; 3, styloid process; 4, capsular ligament; 5, external lateral ligament. (Retouched from Deaver.)

not exercised. With the deep block injections, the needle is never inserted beneath the periosteum, but by the subperiosteal method, the solution is injected beneath the periosteum. If the solution is injected beneath the periosteum, the needle should be slowly advanced, causing as little trauma as possible, and the solution should be injected very slowly. Considerable pressure is required to discharge the solution between the periosteum and bone.

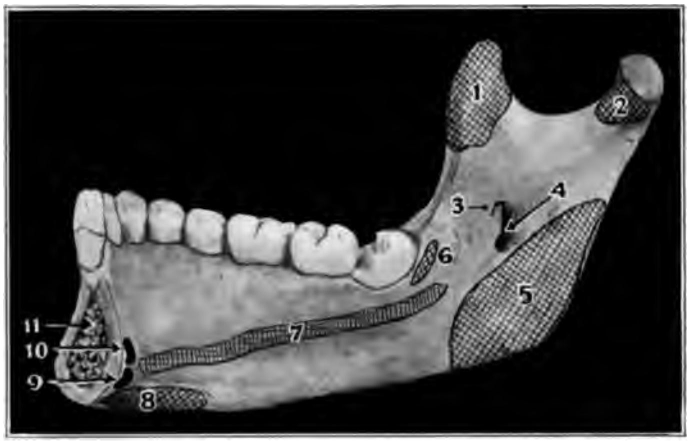


Fig. 144.—Illustrating the attachments of muscles on lingual surface of mandible.

1, Insertion temporal muscle; 2, insertion external pterygoid muscle; 3, lingula; 4, inferior dental foramen; 5, insertion internal pterygoid muscle; 6, insertion (in part) buccinator muscle; 7, origin mylohyoid muscle; 8, insertion anterior belly digastric muscle; 9, geniohyoid muscle; 10, genioglossus muscle; 11, cross section of mandible at median line.

CHAPTER IX

RESPONSIBILITY IN THE USE OF ANESTHETICS

After all precautions are taken, there still remains the fact that we are confronted with occasional accidents following the use of both local and general anesthetics. Therefore, the question of responsibility attending the use of anesthetics is important. In some cases it is rather difficult to decide whether a local or general anesthetic is the agent to employ, even after we consider all aspects of the case in hand. Not only the personal wishes of the patient must be considered, but his physical condition and the nature of the operation must always be weighed with due care and deliberation. After the anesthetic has been decided upon, the operator must be his own judge concerning his fitness and training as to how far he will assume the responsibility which is placed upon him. We are aware of the fact that the dental curriculum heretofore has not been sufficient to thoroughly train the dentist in the clinic in physical diagnosis, pathology, physiology, anesthesia, and allied subjects to thoroughly qualify him to assume the responsibility of administering all anesthetics for prolonged anesthesia, unless he has taken additional training in medical subjects and anesthesia. To be prepared to meet any contigencies that may arise in the administration of local anesthetics, nitrous oxid-oxygen, ether and chloroform, the practitioner should have special training and considerable clinical experience. This statement is not made with the view of discouraging the dental practitioner in any way from employing block anesthesia or general anesthesia in his practice, but with the intention of impressing the operator that he is assuming considerable responsibility when he brings about a state of anesthesia, be it local or general. It must always be remembered that any agent which has for its object the production of an abnormal condition, such as produced through the medium of general or local anesthetics, is more or less dangerous. The anesthetist who has had considerable experience in the administration of both local and general anesthetics has, no doubt, encountered cases which have caused him to employ all the efficient methods of resuscitation as quickly as possible to combat shock and collapse. The specialty of anesthesia covers an immense field and demands thorough training in medical subjects. The specialist in anesthesia carefully selects and employs the anesthetic agent which is best adapted to the case in hand, and the method employed is one that produces the least detrimental effect upon the human organism. As yet, there is no ideal anesthetic agent, be it local or general, but by means of a careful selection of all the agents that are at our disposal, always taking into consideration the physical condition of the patient, the nature and duration of the operation, we aim to attain the highest ideal.

In the course of dental practice the practitioner may many times be confronted with patients for whom a general anesthetic is indicated. If the practitioner does not feel that he is fully competent to make deep nerve block injections, or to administer nitrous oxid-oxygen or ether, extending over an indefinite period of time, he should not assume the responsibility. In such cases it is much better for both parties concerned that the operator confer with the patient's physician and allow him to assume the responsibility of physical diagnosis and the anesthesia. These suggestions are based upon the appreciation of what might be the result of an accidental death and afterward making evident that the anesthetic was employed without taking every reasonable precaution. The operator or anesthetist is duty bound and professionally bound never to undertake any operation without being thoroughly competent to do it in a skillful and learned manner. In the opinion of the author, the injection of large quantities of a local anesthetic solution, such as procain, cocain, alypin, stovain, etc., requires at least as much acumen as does a general anesthetic, and just as much care should be exercised during the injection of a quantity of solution as when nitrous oxid-oxygen, ether or chloroform, is employed. If a medical or dental practitioner administers a local or general anesthetic carelessly, or reveals ignorance as to his knowledge of physical diagnosis, and the signs and dangers of anesthesia, he becomes guilty of malpractice. A practitioner who subjects his patient to the influence of an anesthetic is expected to know how to carry out that part of his professional treatment. He is not allowed, except under exceptional circumstances, to permit an unqualified person to give an anesthetic to his patient, and he is also forbidden to give an anesthetic for an unqualified person, such as an unregistered physician or dentist, or if he administers an anesthetic to a minor without the consent of the parents, or for an illegal operation, he can be held responsible for such acts. If the medical or dental practitioner gives a local or general anesthetic and does not represent himself to be a person duly qualified by law, he can be placed under legal censorship if his patient suffers injury as the result of such an action. In case of accident or death, it rests with the anesthetist to prove that the steps he took in the administration of the anesthetic were carefully adopted after due consideration and because he believed them to be the best he could follow in the interest of his patient. The following questions should always be considered:

1. Did the operator possess all the necessary facts with reference to the physical condition of his patient?

2. Did he find certain pathological conditions existing, and did he make due allowance for them in the treatment which he pursued?

3. Following the physical examination of his patient, did he employ the most suitable agent according to his view of the exigencies of the case?

4. Was the anesthetic administered with all due skill?

5. Was the anesthetic employed, recognized among the efficient anesthetics?

6. Was the local or general anesthetic administered the safest which could have been employed in that individual case?

7. Did the dentist, physician, or anesthetist undertake a duty which his previous training, knowledge, skill and experience had qualified him to fulfill?

8. When collapse, shock or anesthetic accident took place, did he adopt the appropriate treatment indicated in such an emergency?

9. Was the measure of resuscitation instituted with due promptitude?

In the eyes of the law a physician or dentist, who is a legally registered practitioner, is entitled to administer an anesthetic in the performance of his professional duty, and in case a fatality should occur and a malpractice suit be filed, the practitioner is then required to show that he exercised reasonable care and skill in the administration of the anesthetic. However, there is no exact definition of what constitutes "reasonable care and skill." If the practitioner is a specialist, then a higher standard of skill would no doubt be expected of him than from the physician or dentist who is not a specialist. If the anesthetist possesses only the average skill of a practitioner, and administers the anesthetic to a patient in whom no unusual difficulty is expected, or even if the case was "borderland," and he could show that the administration of the anesthetic was absolutely necessary, and that no one else could be obtained for the purpose, he is not likely to be held responsible for the fatality unless the court could prove he displayed extreme ignorance or carelessness. On the other hand, if a competent practitioner or anesthetist could have been obtained for the administration of the anesthetic and his services were not secured, the court would no doubt hold him responsible for the ill effect ensuing. Any physician or dentist who is the least bit doubtful as to his own thoroughness with reference to the proper examination of the patient and the thorough administration of the anesthetic should, therefore, study not only the interest of the patient and himself, but the possible outcome should he take charge of the case and assume the responsibility. When a patient dies under the influence of an anesthetic, be it local or general, in the hands of a medical or dental practitioner, the first questions asked are:

1. What was the anesthetic employed?

2. Was all due care exercised during its administration?

In some cases the patient may refuse a certain anesthetic, or he may refuse local anesthesia, preferring some other method. In such a case the operator or anesthetist cannot shirk his responsibility, as he is duty and legally bound to administer the anesthetic agent, be it local or general, which he deems best, if actual danger is involved in deferring to the wish of the patient. The following example may be cited:

Suppose a patient goes to the office of a dentist for treatment, say for the extraction of a tooth, and the dentist administers chloroform, especially with the patient assuming an upright position in the dental chair, which is often the case. If the result is a fatality, the dentist may be held responsible or, at least, he will be severely censured on the following grounds:

1. He employed the upright position of his patient which is contraindicated.
2. He employed chloroform when a safer anesthetic could have been used, such as nitrous oxid-oxygen or block anesthesia.

Another example of criminal neglect or professional incompetence is as follows:

A patient visits a dental office for some minor operation, and after a physical examination the operator finds some pathological condition which contraindicates a general anesthetic. The operator then advises the patient that a local anesthetic should be employed, but the patient insists upon a general anesthetic. The operator complies with the wishes of the patient against his physical findings, and a general anesthetic is administered which results in death. In such a case he would be held to answer for incompetency and criminal neglect.

The desires and wishes of the patient should be complied with, if possible, but never in a case where the method is contraindicated and against a successful outcome. In case of serious accident, the operator or anesthetist may be required to show that his special knowledge guided him in making his selection of the methods or anesthetic, which, although it led to a fatal result, was in point of fact the best choice he could make in the patient's interest. In case the operator should employ a new anesthetic or one which has not been accepted by competent practitioners in the profession, or, in other words, if it does not occupy a position among other efficient anesthetics, or if he injects a local anesthetic solution having a secret formula and of unknown toxicity and percentage of ingredients, in case of accident he would be placed under a very grave responsibility and would be held liable. A qualified dental practitioner has the right to administer an anesthetic in the course of his practice if he is a graduate of a reputable dental college and is thoroughly competent and has received the proper clinical experience and training in physical diagnosis, chemistry, physiological action, properties and behavior of anesthetics. However, the right to administer an anesthetic, whether it be given by an anesthetist, physician or dentist, depends upon his knowledge, skill and experience. No dentist should ever attempt to make deep nerve block injections or to administer general anesthetics unless he is familiar with all details of the technic connected with their proper administration. In case he should have an accident or fatality in his office, the coroner's jury or court, no doubt, would question more closely his right to administer anesthetics than if the same accident occurred in the office of a physician. On the other hand, the physician might not be as competent to administer the anesthetic as the dentist. The dental practitioner, who is making deep nerve block injections or administering different general anesthetics in his practice should take the necessary precautions to surround himself with every possible safeguard. In case the practitioner is a young graduate, and has been so unfortunate as to have had a fatality in his office, and is called to the witness stand and the courts can prove that he only possessed a theoretical knowledge in anesthetics, physical diagnosis and the other allied subjects, doubtless he would be placed in a very embarrassing position. If it is the desire of the dentist to administer different forms of anesthetics in his practice or to make a specialty of anesthesia, he should by all means, for his own protection, make a special study of the subject with a practitioner of recognized ability, and prepare himself in all of its branches. He owes this not only to himself but to those individuals who place their lives in his keeping. In case the dentist meets with a fatality in his office, he may be questioned as to the restoratives and antidotes he employed; also what measures of resuscitation were instituted; so it not only behooves the dentist to have a knowledge of what drugs and measures are necessary to employ, but it is also essential to keep the required drugs and appliances on hand so they can be used at a moment's notice. (See Chapter XXXVI on Syncope, Collapse, and Shock.)

In concluding this chapter, it may be said that a dental practitioner has the right to administer a local or general anesthetic in his practice, unless there is a statute which prohibits it, and provided, as previously remarked, he is thoroughly competent, possesses the knowledge, skill and experience, if the operation which is undertaken is within the scope of dental surgery, and the local anesthetic injected, or the general anesthetic administered, is one which is recognized by the professions of medicine and dentistry. If he can show that proper diligence and skill were carried out in the administration, he (the dental practitioner) would not be held liable for an accident. It is true, no practitioner, be he dental or medical, desires to have a fatality, so the repetition of the old saying is applicable here, namely, "be sure you are right, then go ahead."

The operator should by all means prepare himself if he intends to derive the most good from either local or general anesthesia, and he should have a reasonable knowledge of physical diagnosis. He should be familiar with the anatomical parts, the therapeutic action of the drugs that are used in resuscitation, the methods of resuscitation, and be ready to meet any emergency that arises. In case he has mastered this subject and its important allied subjects, he will be in a position to meet the most difficult cases, and in the event of a fatality he can prove to the court that he used all due skill and care in the treatment of the case.

It must be remembered that the one thing which causes most of the distressing fatalities in anesthetics is the lack of resistance or lowering of the vitality of the patient. Often there is some latent pathological condition which is overlooked, even by the most careful diagnostician. In other words, if it was possible to anticipate the exact physical condition of each patient, the operator would frequently see that the use of anesthetic would result fatally or create serious complications.

The general law in Illinois, as well as in other states where there is no statute, is that a physician or dentist who administers a local or general anesthetic must employ that degree of skill and caution which would ordinarily be exercised by a competent, careful, and skillful physician or dentist under the same circumstances.

In examining the statutes with reference to the law governing the administration of local and general anesthetics by an anesthetist, physician, or dentist, it is found that West Virginia and Ohio have statutory laws upon this subject:

The Code of West Virginia, 1913, Section 5,375, provides:

"It shall be unlawful for any physician, dentist or other person to administer chloroform, ether or any anesthetic whatsoever, whereby sleep or total loss of sensation may be produced to any female person, unless in the presence of some third person. Any person offending against this act shall upon conviction thereof, be fined not exceeding one hundred dollars or be confined in the county jail not more than sixty days, or both."

The Ohio General Code of 1910, Section 12,678, provides that:

"Whoever uses upon another an anesthetic unless, at its administration and during the whole time the person is wholly or partly under its influence, there is present a third person competent to be a witness, shall be fined not less than $5.00 nor more than $25.00."

CHAPTER X

BLOCK ANESTHESIA, NERVE BLOCKING, OR CONDUCTION METHOD

It is highly gratifying to the members of the medical and dental professions to realize that the birthplace of both general and local anesthesia was in the United States, and was principally developed by American surgeons, dentists, and anesthetists. It was J. Leonard Corning, an American, who, in 1885, first suggested and demonstrated the method of blocking nerve trunks through the medium of cocain. During the same year Halsted blocked the inferior dental nerve with a cocain solution. (See page 26.) Other American surgeons who did pioneer work were Matas, Crile, and Cushing.

To Dr. George W. Crile, Lakeside Hospital, Cleveland, Ohio, belongs the credit for first employing nerve blocking by the direct intraneural method in major operations. Crile performed amputation of the leg in five cases, his first operation having been performed May 18, 1897. This was accomplished by blocking the sciatic and femoral nerve trunks. The case was reported in a paper read before the Ohio State Medical Society. He also blocked the brachial plexus for amputation of the arm; also suggested the blocking of the ulnar nerve at the elbow, and the peroneal nerve at the knee. Matas performed many operations under block anesthesia upon the arm, hand, leg and foot. Credit belongs to Cushing for first employing block anesthesia in the operation for inguinal hernia.

Crile's object in blocking these nerves was to diminish or eliminate shock, and this was the beginning of the most remarkable experimental work to avoid shock that has been done in recent years. The results of his research within recent times have attracted the attention of modern surgeons, dentists and anesthetists throughout the world. At that time, Crile called it "the blocking method," from the fact that the solution of cocain injected anèsthetized the nerve trunks, thereby blocking all of the afferent, traumatic, irritant, and sensory impulses at the site of operation.

The work of Crile has opened up a very fertile field, and he has coined the new term, "*anoci-association*," which means the blocking of all factors which are detrimental to the patient during the operation; all factors which tend to prolong the postoperative recovery of the patient; all factors which affect respiration and blood pressure, as well as the blocking of all afferent sensory impulses.

The writer will not attempt to discuss anoci-association under this heading, but the reader is referred to page 828 for a discussion of this subject, and its practical application in oral and dental surgery.

Action and Duration of Cocain.—It was an important discovery Corning made known when he announced that the action and duration of cocain could be varied and nerves blocked indefinitely when constrictors or mechanical devices were employed to impede or arrest the circulation at the point of injection. Various methods were used until the active principle of the suprarenal gland was isolated and employed in conjunction with cocain. The isolation of adrenalin was a great step forward in nerve blocking. Adrenalin is a therapeutic constrictor and produces vaso-constriction of the arterioles of the part injected, and the duration of anesthesia can be maintained in accordance with the amount of vaso-constricting agent contained in the injecting solution.

As soon as *adrenalin* was isolated, it opened up a new field which, at the present time, is one of the most important adjuncts to the domain of anesthetics. Corning first suggested and popularized nerve blocking as a result of his numerous practical demonstrations and contributions on the subject.

As early as 1885 he demonstrated that a sectional area of a large nerve trunk in any part of its course could be easily blocked with the proper anesthetizing solution, thus blocking or inhibiting all sensory afferent impulses arising from the entire peripheral distribution of the nerve trunk injected, in that way producing deep anesthesia over all parts supplied by the large trunk injected.

Corning in 1885 ligated the upper part of the arm and blocked the nervus cutaneus antebrachii by injecting five minims of a four per cent solution of cocain. Following this injection he observed almost immediately that he had secured anesthesia in the skin of the wrist supplied by this nerve, and which was several inches from the point where the nerve trunk was injected.

Following Corning's discovery, other investigators added to this important link of anesthesia, and among them were Schleich, Reclus, Halsted, Hall, Feinberg, Offerhaus, Härtel, Matas, Topas, Patrick, Keller, Bodine, Schlosser, Hackenbruch, Braum, Kochs, Alms, Witzel, Robson, Mosso, Kummer, Frank, Chandleux, Goldschneider, Sidel, Pernice, Bier, Heinz, Einhorn, Peckert, Ritter, and Takamine. (See page 26 for names of recent investigators.)

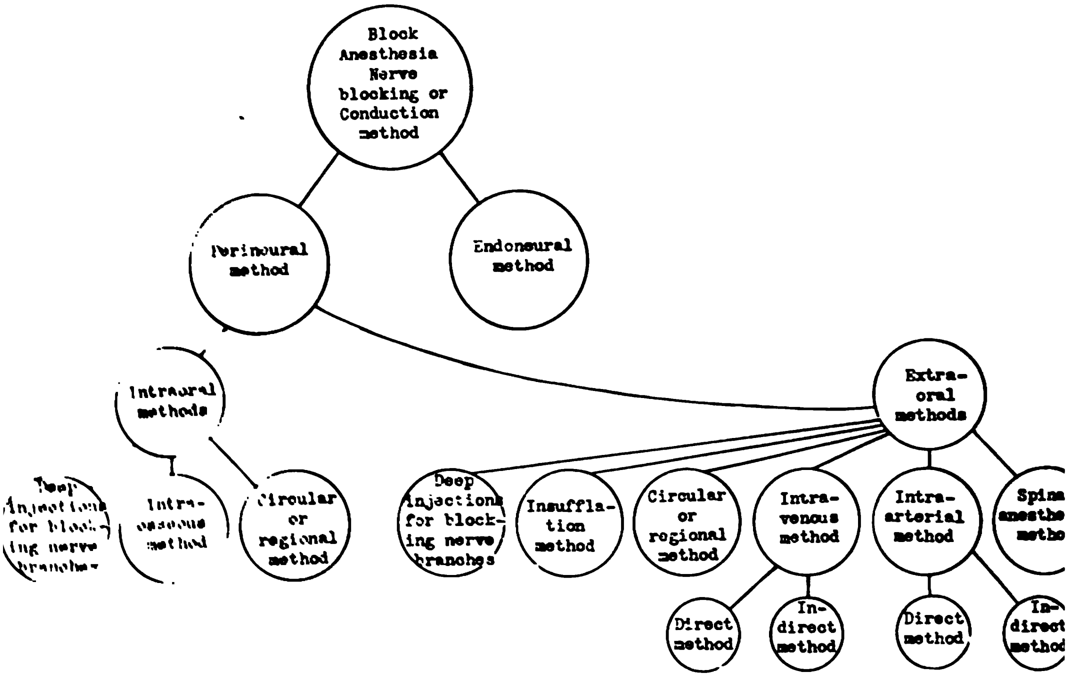
Great strides have been made in local anesthesia, and the modern trend has been toward that of blocking the deep nerve trunks in preference to other methods. The technic, which has been worked out, has made it possible not only to employ this branch of local anesthesia to great advantage in oral and dental surgery, but for a countless number of major operations which heretofore were performed only under general anesthesia. It is needless to say that blocking the nerve trunks supplying certain areas should only be employed in cases where it is possible to block completely the operative area and render it insensible to pain. Block anesthesia is technical and demands a careful and skillful technic in its employment, in order to obtain satisfactory results for both operator and the patient. Considerable skill is required in making the deep nerve blocking injections, and every one must experience difficulties at the beginning. The operator should charge his failure to the imperfect technic used, and should search diligently for the cause of that failure and strive to overcome it.

The writer desires to emphasize the fact that nerve trunks can be completely anesthetized by injecting the solution in several different ways, and it seems appropriate at this time that the various methods should be discussed.

BLOCK ANESTHESIA

Definition.—Block anesthesia is defined as the method of producing insensibility in a part by blocking the nerve trunk or trunks which supply that part by the injection of a local anesthetic solution at a point distant from the field of operation. Or, nerve blocking may be defined as the method of producing anesthesia by inhibiting the sensory afferent impulses of the nerve trunk or trunks by the injection of a local anesthetic solution at any point between the area of operation and the brain. Accurate technic and a thorough anatomic knowledge of the nerves, their location and distribution, is necessary in order to obtain the best results.

Classification of Block Anesthesia, Nerve Blocking, or Conduction Method



The reader will observe that block anesthesia, nerve blocking or conduction method, as illustrated in the above drawing, is divided into two great divisions, which are:

1. Perineural or indirect.
2. Endoneural or direct.

Nerve blocking for oral and dental surgery is again divided into the intraoral and extraoral methods.

Perineural or Indirect Method.—The indirect or perineural method is defined as that method of producing anesthesia of a nerve trunk by injecting the solution into the immediate region of the nerve. When the solution is deposited within the connective tissue, in the immediate neighborhood of the nerve trunk it infiltrates through the epineurium to the nerve fibers which block the afferent sensory impulses. The connective tissue, which is situated in the immediate region of nerve trunks, is readily permeated by the injecting solution. If the diameter of the nerve injected is quite large, it will take a little longer for the solution to permeate the connective tissue in comparison with a smaller nerve, which is not surrounded with as much connective tissue. For example, it would take a considerably longer time to anesthetize the sciatic, radial or ulnar nerves than it would the posterior superior alveolar nerve. We know from our study of histology and anatomy, that the diameter of a nerve trunk is greater as it passes toward its proximal end, also, the connective tissue surrounding the nerve is gradually increased. When the solution is injected by the perineural or indirect method, there is an area of infiltration which takes place in all directions from the injected part, and in addition to the local infiltration, the nerve branch, which is located in the injected area, is blocked, provided the solution has not been injected too far from the nerve branch and has been of the correct percentage and quantity.

It is interesting to note that when the solution has been injected into the spinal canal, only a very short time elapses before anesthesia has supervened. This is explained on the ground that at the point of injection the solution comes in contact with the nerve trunks which are not protected by the connective tissue cover. The operator must remember that the depth of anesthesia and the time required to produce anesthesia depends upon the skill of the operator, the diameter of the nerve trunk, strength and quantity of the solution.

The perineural or indirect method of nerve blocking does not require as much skill as the endoneural method, for the nerve trunk is not pierced by the needle. When a perineural injection is made, the needle is inserted into the tissues surrounding a nerve trunk, and the solution is injected. This method of nerve blocking demands a larger quantity of injecting solution of greater strength than when the nerve is blocked by the endoneural method. However, when the point of the needle is inserted near or in contact with the outer part of the nerve trunk, and the solution is injected at that point, diffusion of the solution rapidly takes place through the connective tissue sheath and the nerve fibers composing the nerve trunk.

The reader should remember that the smaller nerves possess a very thin sheath, and that this sheath increases in thickness as the nerve passes in a central direction, and it also increases in proportion to the diameter of the nerve trunk, and the thinner the sheath, the more readily the solution will permeate the nerve, thereby blocking the passage of all sensory impulses.

Time to Wait for Anesthesia.—The writer has been asked *"How long do you have to wait for anesthesia?"* hundreds of times. When we stop to consider such a question, it covers a very broad field, and the answer is as follows: The time elapsing for anesthesia depends upon four important factors:

1. The diameter of the nerve trunk to be blocked.
2. The percentage of solution used.
3. The quantity of solution injected.
4. The accuracy of injection.

1. It is self-evident that it takes a longer time for a solution to permeate a nerve, say three or four millimeters in diameter than a nerve branch which is one-half to one millimeter in diameter; therefore, we must always consider the diameter of the nerve trunk we are blocking and not expect anesthesia immediately following the blocking of the second and third divisions of the fifth cranial nerve as quickly as some of the smaller branches of these same two divisions.

2. Another factor which must always be borne in mind relative to the time element, is the percentage of solution injected. A much quicker and deeper anesthesia will result following the injection of say a two per cent solution than a much weaker solution, of say one-quarter per cent.

3. The quantity of solution injected must always be considered in estimating the time necessary for producing anesthesia. If the operator is familiar with his anatomy and knows exactly where the nerve branch is situated, he will not find it necessary to inject as much solution as the operator who is less familiar with his anatomy and inserts the needle more or less at random. The injection of an excessive quantity of solution frequently serves as a cloak to hide the ignorance of the operator's knowledge of anatomy. Some operators use a much larger amount of solution in producing anesthesia of a nerve trunk than is required by the operator who has a thorough knowledge of anatomy. The amount of solution used is in ratio to the operator's knowledge of neural anatomy.

4. When the solution is injected at a point too far from the nerve trunk, little or none of the anesthetizing solution will reach the nerve branch, and, not only incomplete anesthesia is the result, but considerable time must elapse before partial anesthesia can be secured. However, if the solution is deposited near or in contact with the nerve trunk, little time will elapse before anesthesia is complete in the part supplied by the nerve.

The Endoneural or Direct Method.—The direct or endoneural method is defined as that method of producing anesthesia by inserting the needle beneath the epineurium into the nerve trunk which supplies the operative field, and injecting the solution into the nerve itself. As previously remarked, this method is seldom, if ever, employed today, and as far as the writer can learn, has never been used in making injections in oral and dental

Crile first advocated the exposure of the branches of the brachial plexus just above the clavicle. He isolated each individual nerve and injected it by the endoneural method. Following this, both Crile and Matas, as well as other surgeons, performed various other operations by the use of this method. A very fine sharp needle was used and the fluid was introduced beneath the epineurium, into the central part of the nerve trunk, while the needle was held parallel to the long axis of the nerve. When this method is employed, it is necessary to inject only a few minims of the solution, as the solution is in actual contact with the nerve. It is of interest to know that if the nerve injected in this manner is perfectly healthy, the injection will cause very little pain, particularly if the needle is fine and sharp and the nerve is not pulled upon during the injection; but, on the other hand, if the nerve is in a state of inflammation, which has extended from some other area, the solution injected in this manner will cause pain. Inasmuch as the endoneural method is not practiced in oral and dental surgery the writer does not deem it essential to enter into further discussion of this method.

The term *conduction* was introduced in 1903 by Braun, and this word has been used somewhat extensively in literature, but it appears to the author that the term *block anesthesia* or nerve blocking is to be preferred, as the terms themselves are self-explanatory.

Demonstration by Braun.—Braun in 1908 demonstrated that he could block certain nerve tissues, such as the median, radial, tibial, ulnar, and numerous other nerve trunks by injecting a diluted solution of cocain after ligating above the point of injection; or that the same results could be obtained by adding suprarenal extract to the injecting solution which acts as a vaso-constricting agent. He also found that following a nerve blocking injection, an interruption of the sensory motor impulses occurred, and that a motor and sensory paralysis soon took place.

Heidenhain's experiments led him to make the statement that the sensory nerve branches are affected prior to the motor nerve branches, and that they have the power to retain their insensibility to sensory impulses long after the motor nerves have retained their power to conduct motor impulses.

Adrenalin.—Since the active principle of the suprarenal gland which is called adrenalin has been isolated, as well as the successful compounding of synthetic suprarenin, local anesthetic solutions have been placed upon a definite scientific basis. Had it not been for the discovery of the vaso-constricting agent adrenalin, we would not be enjoying the wonderful success with local anesthesia which is our good fortune at the present time. Before the active principle of the suprarenal gland was discovered, it was necessary to apply a tourniquet to the extremity above the point of injection, in order to prevent rapid absorption of the local anesthetic, but this is not necessary since suprarenin has been added to the solution, for it is now possible to secure just as good results, as far as the injecting solution is concerned, in other parts of the body as it is upon an extremity. *If the nerve trunks have been completely anesthetized, all painful impulses and the thermal sense are blocked. The tactile sense is greatly obtunded, but is not completely absent, and the muscular sense is impaired. When the nerve trunk or trunks have been blocked and are in a state of profound anesthesia, they will remain in this state, as long as the circulation is partially or totally arrested through the action of the vaso-constricting agent. If the vaso-constricting content is not sufficient to cause a vaso-constriction of the blood vessels, anesthesia will be more transient. If the anesthetic solution is injected, which is free from the drug suprarenin, it is almost impossible to secure anesthesia for the reason that it is rapidly absorbed, and this rapid absorption not only prevents anesthesia from taking place, but it increases the chance of toxic symptoms, because it enters the circulation so rapidly and is not restricted to the circumscribed area of injection.*

Knowledge of Anatomy and Technic Important.—It is a question not to be argued that if the operator is familiar with his anatomy and the technic for making the various nerve blocking injections, gratifying results will be secured by the perineural method. The operator must be familiar with the exact location of the individual nerve trunks, and must know their relationship to certain bony landmarks. However, if the nerves are not situated near any bony landmarks, but in soft parts, greater experience and knowledge is necessary to block them by the perineural method. If the nerve is surrounded by soft parts, the operator can generally detect when the point of the needle is in contact with the nerve branch, as the peripheral sensations of paresthesia in most cases are present when the point of the needle strikes the nerve.

In order to locate more accurately the position of the nerve branches for operations in oral and general surgery, Perthes invented a special needle which was insulated, and after he inserted the needle into the region in which the nerve was located, he passed a faradic current through it, and if the needle was in contact with a nerve containing motor fibers, there was an immediate contraction of the muscles supplied by that nerve. The writer fails to understand how this can be of any value whatsoever to the dental and oral surgeon, and does not recommend it.

The *trigeminus* or fifth cranial nerve is surrounded by many bones, and it is an easy matter for the operator to know exactly where each nerve branch is located, because the various nerve trunks are near or in contact with certain surfaces of various bones situated in the region of the fifth cranial nerve. This is also true for the operator who is practicing head and neck surgery. The oral and dental surgeon may be called upon to block not only the fifth cranial nerve and its branches, but to block other sensory nerves which supply the head and neck, such as the cervical plexus and its branches.

When we stop to consider that scientific technic has been developed, which practically covers the blocking of all the sensory nerves supplying the head and neck, and when we understand anatomy, the details, and the fundamentals which underlie such blocking for anesthesia, it is very gratifying to know that it is just as easy for the experienced operator to block one or more of the nerve trunks as it is for the dentist to grasp his handpiece and prepare a cavity along scientific lines.

Perineural Method One of Choice.—The perineural method of blocking is the one of choice for the oral and dental surgeon, inasmuch as the majority of nerves are small in diameter, such as the terminal branches of the ophthalmic, superior maxillary, and mandibular divisions. The nerve sheaths surrounding these terminal divisions are very thin, and the solution readily diffuses and infiltrates through the connective tissue sheath and permeates the sensory nerve fibers, for example, the blocking of the inferior dental. We know that the inferior dental nerve enters the inferior dental foramen and is in contact with the periosteum covering the inner portion of the ascending ramus in this immediate region. When the needle has been inserted the proper depth and strikes the periosteum in the region of the inferior dental foramen, and the solution is injected at this point, it will be very near the inferior dental nerve and anesthesia will be apparent very quickly. This injection is only one example in calling the reader's attention to the anatomical relation of nerves to bony landmarks, which are of inestimable value to the oral surgeon. Even though the endoneural method possesses a few advantages for blocking certain nerves, it would be impossible to employ the method in oral and dental surgery, for the reason that the operator would not be positive that the needle point had pierced the nerve trunk without making an incision exposing such nerves, and such a procedure would not be practicable.

Most of the nerve branches blocked for oral and dental surgery are of small caliber, with the exception of the second and third divisions of the fifth cranial nerve and the branches of the cervical plexus. Even with these large branches, only a few minutes elapse following the injection until complete anesthesia has been secured. It may be that in some cases the operator inserts the needle into the nerve sheath or into the nerve itself, and injects the solution, but he is never sure that such has been the case, but the quick and profound anesthesia which follows should inform him that the solution was injected into the nerve.

In closing this chapter, the author wishes to emphasize the fact that success in nerve blocking can only be acquired by careful, persistent study of the anatomy of the parts involved, the solutions used, and the appliances necessary. There is no legerdemain in block anesthesia, it is simply understanding the technic.

CHAPTER XI

LOCAL ANESTHESIA FOR OPERATION ON THE HEAD, FACE, JAWS, AND NECK

The application of local anesthesia for operations on the head and neck, is one of the most scientific, fascinating and classical procedures at the disposal of the head surgeon and dental practitioner. The production of local anesthesia by deep nerve blocking or terminal anesthesia, is one of the most brilliant operative triumphs within the domain of oral surgery and operative dentistry.

In recent years there has been such a wonderful development in the technic of nerve blocking, that it has been rather hard for the general practitioner to keep pace with what has been accomplished in research and in the practical application of one of the most useful methods for relieving pain known to science. It is now possible to excise the superior maxilla by nerve blocking, as was demonstrated by Professor Matas, of New Orleans. It is also possible to do partial removal of the tongue, to remove tumors, and perform plastic operations under some form of local anesthesia. *There is no question but that nerve blocking in the hands of the experienced operator is one of the most effective means of producing anesthesia for a large number of operations performed by the general surgeon, eye, ear, nose, and throat specialist, oral surgeon, and general practitioner of dentistry. It is a method that demands a most exact and careful technic, thorough knowledge of anatomic parts, and a distinct adherence to asepsis in order to achieve results. If the technic is slighted in the least, or if the operator is not familiar with the anatomy, or if he disregards asepsis, it is self-evident that he will not obtain satisfactory results, and is only inviting trouble.*

Nerve blocking *is a method of producing anesthesia with which the operator cannot camouflage; in other words, he must be absolutely capable of carrying out the technic to the letter, or failures are certain to occur, and thus cast a reflection upon a valuable method in the hands of those who understand it.*

The author's advice to the beginner is not to take up the subject in a half-hearted manner, but to prosecute it with the firm determination of mastering it. Unless this is his goal and determination, the best place for his hypodermic needles, tablets and other paraphernalia, is in the cabinet, and he should not subject his patient to experimental procedures. When the dental surgeon takes up the subject with the firm resolve of becoming familiar with it, and when he has really done so, he has reached one of the stepping stones towards efficient progress, namely, the elevation of the dental profession in the eyes of the laity.

During the writer's experience, while lecturing and operating in various clinics, he has heard many dentists express themselves with reference to local anesthesia. It is true that many practitioners do not realize the great magnitude of this subject and do not have a clear vision of how it is divided and subdivided, and how it is possible to block small and large circumscribed areas. It is a fact that many dentists are laboring under the impression that about all there is to local anesthesia is a hypodermic syringe, a short needle, and a few tablets, and the injection of the solutions promiscuously into he gum tissues around the tooth. Operators who have this impression, when they observe operations performed under the nerve blocking method, become greatly enthused over what can be accomplished through this medium, and then realize they have not been giving their patients the advantages of many methods coming within the great scope of nerve blocking.

The administration of a local anesthetic is essentially different from the administration of a general anesthetic. It is true, that the operator may only have average ability relative to the administration of a general anesthetic. Let us take, for example, nitrous oxid and oxygen, with which he can produce anesthesia, and in some cases asphyxia, he then performs some short operation. As far as the elimination of pain is concerned, the operation has been a complete success while, on the other hand, if he has made a deep nerve blocking injection and his technic has been imperfect, it is self-evident the patient will experience pain when operating is started. Failure in nearly every case is due to faulty technic. With a general anesthetic the patient is unconscious, and experiences no pain during the operation, but it is quite different with a local anesthetic, for if the technic has been imperfect, the patient will very quickly indicate it. Repeating what we have previously said, the operator can not camouflage with nerve blocking and his patient is the competent judge. If the operator does not know the exact position of the nerve trunk or trunks, their branches or subdivisions; if he does not know how far to insert the needle; if he does not know how much solution to inject; if he does not know the percentage of solution to employ; if he does not know the relationship of the nerve branches to the bony landmarks; if he is not acquainted with the bony structures situated within the operative area; if he does not know the interlacing existing between nerve branches in certain areas, and if he does not know the value and methods of asepsis, his efforts are likely to result in failure, and unless he is endowed with the sticking qualities which go to make up a good student, and continues with the firm determination of overcoming those things which make failures, he is very apt to cast aside one of the most efficient methods for the alleviation of pain.

The operator must not be too hasty in selecting either general or local anesthesia, but must give due consideration to the physical condition of the patient, and his ability in administering either a general or local anesthetic for the operation in hand. Every one agrees that it would be very foolish for an operator to attempt any operation, especially of the major type, under local anesthesia, if he does not possess a knowledge of the technic of blocking and the anatomy involved.

As a result of the research work of many contributors in perfecting this method of anesthesia, operations can now be performed upon almost any region of the body under local anesthesia. It has opened up a new field which demands an intimate knowledge of anatomy, and accuracy in technic. This method requires that the operator shall be familiar with the various foramina, bony prominences, canals, fissures, surface osteology, origin and insertion of muscles, position and relationship of blood vessels, the position and relationship of nerve trunks and their branches.

After several years of study and research with local and general anesthesia, the writer enthusiastically states that the many hours he has spent in working out a new technic and in endeavoring to simplify many injections, have amply rewarded him for his efforts in this respect, and it has been one of the most interesting fields yet investigated.

There seems to be something about this subject that is very attractive and fascinating, and the more one studies it, the more interesting it becomes, and in most cases the student or practitioner is enthusiastic over its possibilities.

The writer has noted, time and again, that many dentists were only partially interested in nerve blocking, until they attended a clinic or heard some lecture upon the subject. They then became interested, began investigations, and in a few months, in most cases, they were highly enthusiastic, and became more so the farther they delved into the subject. At the beginning they were certain to experience failure, and the students who realize that they can profit by the failures, and search for their causes, will overcome them one by one. It has been the author's pleasure to know a number of dentists who availed themselves of the many advantages offered by the dissecting room, utilizing charts, drawings, wet anatomic specimens, etc. The student or practitioner must always remember that the close application to study, stimulated by the failures he may have experienced at the beginning, are simply stepping stones towards mastering the details of technic required in making the various deep nerve blocking injections, for success comes in no other way.

The dentist who makes the statement that he is practicing nerve block and, in reality, is injecting the solution into the gum tissue around the tooth, is by no means practicing what he says he is, but instead, he is merely employing the submucous or peridental method of anesthesia. It is indeed gratifying to remark that operations upon the head, neck, face and jaws have entered the great scope of nerve blocking and of regional local anesthesia methods. Practically all of the injections into these parts can be made with surprising ease when the primary difficulty encountered by the beginner is overcome and the exact technic has been mastered.

Since the advent of the extraoral and intraoral methods of blocking the various nerve branches for oral surgery and operative dentistry, as well as the blocking of certain areas for plastic surgery, it has been shown that in the majority of cases local anesthesia is superior to general anesthesia for operations upon these parts. The amount of hemorrhage which is always encountered, the presence of blood and mucus, the swallowing of the patient's tongue, all tend to increase the operator's and anesthetist's responsibility, also increasing the number of assistants, and last, but not least, the field of operation is crowded.

ANESTHESIA FOR OPERATIONS UPON THE FACE

The face offers an attractive field for nerve blocking and terminal anesthesia, in view of the fact that the parts have a definite nerve supply; and if the operator understands his neural anatomy, it is an easy matter to block any circumscribed area, or, in fact, the entire face. The definite location of the sensory nerve branches makes the anesthetizing of them a highly attractive field for nerve blocking anesthesia.

The blocking of the tissues of the face proved of immeasurable value in performing plastic surgery operations upon the soldiers in the recent war. It was with great satisfaction and pleasure that the author assisted and gave instruction to many who later made use of this method with gratifying results in the cases of soldiers who were operated. Not only is the nerve blocking method of value for plastic operations, on account of the cosmetic effect, but also for operations in dealing with such pathologic conditions as the removal of cysts, nevi, tumors, moles, the opening of abscesses, and the closure of wounds.

If the operation involves only the soft structures, such as the skin, subcutaneous connective tissue, muscles, etc., terminal anesthesia will be sufficient, and if the solution is injected properly, perfect anesthesia will follow. Whereas if the operation is for the removal of an epithelioma, or for some other condition which involves not only the soft structures, but may extend to the bone, so that some part of the bone may necessarily have to be removed, it is far better to employ nerve blocking than it is the terminal method. The operator must be his own judge in deciding whether it is better to select nerve blocking or terminal anesthesia, and his decision should be in accordance with the amount and kind of tissue involved.

The **deep nerve blocking** injections, employed for blocking the various regions of the face, depend upon the site of the operation, and whether or not the superficial or deep tissues are involved. For example, if the operation be for harelip, the nerve blocking injections would be a right and left extraoral or intraoral, infraorbital. Two mils (c.c.) of the solution would be injected at each infraorbital foramen. These two injections will anesthetize the entire upper lip as well as the skin and other soft structures beneath the two infraorbital foramina and the lateral walls of the nose. If the operation is for the removal of a mole or nevi situated beneath the infraorbital foramen or lateral to the side of the nose, only one infraorbital injection is necessary. If the operation is for the removal of an epithelioma of the lower lip, then the injections would be given to block the inferior dental nerve on the right and left sides.

The lower lip may be involved to a considerable extent by the epithelioma, and in many cases it is necessary to block the branches from the cervical plexus, in addition to the blocking of the two inferior dentals. The branches from the cervical plexus are blocked by either nerve blocking or preferably by the terminal anesthesia method which is accomplished by infiltrating the skin and other tissues beneath the area of the epithelioma.

If the operation is for plastic surgery of the nose, whereby the nose will be changed in shape, such as the grafting of a piece to restore the bridge, or the removal of excess bone which forms the so-called "hump" nose, or the grafting of skin from the arm or the finger to form the nose, deep terminal anesthesia of the part is in most cases highly satisfactory. In case the operation should involve only the soft structures, then terminal anesthesia, can be employed by making the terminal injections by the circular method, as is illustrated in Fig. 473.

The technic for anesthetizing the lower or upper lip by the circular method is to surround the operative field by a zone of anesthesia, inserting the needle entirely outside the limitations of the growth. The needle should be advanced until it strikes the periosteum, injecting continuously from the time it enters the skin until the periosteum has been reached, in order to eliminate pain incident to the insertion of the needle. The needle is withdrawn, and the injections are repeated as often as necessary, the number of times depending on the growth to be removed. (See page 673 for technic.)

If the operator so desires, he can block the second or third divisions of the fifth nerve by either the intraoral or extraoral method, instead of by the infraorbital or terminal injections.

Nerve Blocking for Removal of Tumors.—There is no place on the body where a tumor will vary from benign to malignant more than is the case of the tissues of the face and jaws. We are aware of the fact that an epithelioma located on the lip, is highly malignant. The form of sarcoma of the jaw called epulis is of a low malignant type, whereas osteosarcoma is highly malignant. The writer's object in making these statements is to point out that the operator must be competent to make the various nerve blocking injections before he attempts the operation, in view of the fact that the operation may involve greater tissue than he anticipated at the beginning, and for that reason, if he can not block the deep tissues, he must then resort to general anesthesia. Undoubtedly, this one feature has caused trouble for the reason that the oral surgeon or dentist many times only removes a part of some malignant growth under local anesthesia, therefore leaving tissue which tells the story at a future time. A local anesthetic used in this manner is, of course, a detriment, and it is quite true we could take advantage of many good methods, if we so desired, but if local anesthesia is utilized in any such manner, it does not speak so much against this efficient method, as it casts a reflection on the knowledge and the ability of the operator who misused it.

If the operator is not thoroughly satisfied with his diagnosis as to whether the growth is malignant, he should by no means tinker with a pathologic condition which may involve the tissues to any great extent. The physical and mental condition of the patient may be such as to demand general anesthesia. This holds true particularly for highly malignant growths, such as osteosarcoma, or sarcoma of the submaxillary bones, or carcinoma of the lip and tongue. Local anesthesia has the great advantage for the operator in securing a much earlier consent to operate than is many times possible with a general anesthetic, and not only this, but many operations can be performed in two stages, which is extremely advantageous in order to lessen the amount of hemorrhage.

CHAPTER XII

THE NERVE BLOCKING METHOD FOR ORAL AND DENTAL SURGERY

Block anesthesia has already been defined as the method of rendering the area of operation insensitive to pain by blocking all sensory nerve branches supplying it through the medium of a local anesthetic. This is truly nerve blocking and is accomplished by injecting the solution in or near the nerve trunk, while the other methods classified under nerve blocking are modifications. (See diagram on page 194.)

The blocking of nerve trunks for oral and plastic surgery, operative dentistry, as well as other numerous head and neck operations, has advanced to such an extent that all the injections can now be given by following a definite technic. The nerve branches supplying the jaws, face, neck and scalp have in most cases a definite location, and when the operator once understands and has mastered the technic, little or no difficulty is encountered in producing a rapid and complete anesthesia.

Nerve blocking for oral and plastic surgery and operative dentistry is divided into two divisions, thus:

1. Intraoral method.
2. Extraoral method.

INTRAORAL METHOD

The intraoral method is that manner of blocking the various nerve branches by way of the oral cavity. The needle is inserted into the tissues at various definite locations which depend upon the nerve or nerve branches to be blocked. The intraoral method of nerve blocking is of unlimited value to the dental practitioner, and will be used much oftener than the extraoral method. The technic for injections by the intraoral method for blocking the various nerve branches of the second division of the fifth nerve, which supplies the upper jaw and immediate region, has been more difficult to perfect and master than the injections for blocking the lower jaw. The nerves which supply the superior maxillary region are more complicated in their origin and distribution than those supplying the region of the lower jaw. The anatomic arrangement of these nerves has made them difficult of access, and this has complicated the problem of working out a definite technic whereby they can be blocked with accuracy. The operator may rest assured that if he injects the solution in the proper location, anesthesia will be secured.

Failure in most cases indicates a lack of knowledge of anatomy and the technic. Nerve blocking as it is today, enjoying its modern perfection of technic, has *placed a harmless method at the door of every oral surgeon and dentist that is of inestimable value, and if applied in an intelligent manner is practically void of danger or complications, and will in nearly every case relieve the patient of all pain accompanying oral surgery and dental operations, and it deserves the most careful consideration of every conscientious, progressive member of the dental profession.*

Indications for Intraoral Method

(A) For oral surgery operations not complicated by infection, pus, etc., such as:

1. Removal of teeth.
2. Resections of alveolar process.
3. Opening and treating the superior maxillary sinus.
4. Removal of an epulis, cyst, or ranula.
5. Trimming gum tissue.
6. Suturing.
7. Removal of impacted teeth.
8. Curettement of tooth sockets.
9. Removal of fragments of necrosed bone.
10. Cleft palate (on adult).
11. Harelip (on adult).
12. Removal of pulp stones.
13. Entering pulp chamber to relieve congestion and pressure.
14. Also other operations coming under the observation of the oral surgeon and dentist.

(B) For operative dentistry, such as:

1. Cavity preparation for all classes of sensitive cavities.
2. Preparation of teeth for crown and bridge work.
3. Extirpation of pulps.
4. Desensitizing soft palate for taking impressions for a denture.
5. Treatment of erosion.
6. Application of ligatures.
7. Application of separator.
8. Application of rubber dam or cervical clamps for cervical cavities.

(C) In periodontia and pyorrhea alveolaris operations, such as:

1. Scaling and curetting pyorrheal roots and sockets.
2. Excising or cauterizing gum flaps which would retain infection.
3. Treatment of pathologic conditions of the peridental membrane and applications of strong acids to dissolve carious bone in sockets.

Contraindications for Intraoral Method

1. In any cases where considerable infection is present, it would be unwise to insert the needle into the tissue if pus is present.
2. In case the tissues are highly inflamed and swollen.

3. In case the jaws can not be opened sufficiently wide to insert the needle, owing to inflammation and pain.

4. In case there is extensive trauma, as following an injury.

6. Deep nerve blocking injections should never be attempted by an operator who is not familiar with the anatomy, rules for asepsis and each step of the technic. Failure in most instances is due to the operator's faulty technic and imperfection of methods.

EXTRAORAL METHOD

The extraoral method of blocking the various nerve branches is accomplished by the insertion of the needle through the skin from the exterior. This method is of unquestionable value to the oral and plastic surgeon. The general practitioner of dentistry meets occasional cases wherein the extraoral method would be far superior to the intraoral method as, for example, the blocking of the anterior superior alveolar nerve which supplies the upper central, lateral, and cuspid teeth. To block this nerve intraorally the needle is inserted into the mucous fold to the buccal of the apex of the upper second bicuspid tooth. If there is extensive inflammation present, such as an acute alveolar abscess, it is not good practice to insert the needle through tissue of this character. In such a case the blocking is best accomplished by injecting the solution at the infraorbital foramen by the extraoral method (for technic, see page 494). This is only one example in which the extraoral method is indicated over the intraoral method. (See "Contraindications for Intraoral Method" and "Indications for Extraoral Method," this Chapter.)

It has been the writer's experience in giving clinics to observe the fact that nearly every dentist hesitates in making extraoral injections. The author has asked a number why they felt reluctant to employ this method in cases where it was indicated, and in most cases their answer has been that they were afraid they did not understand the technic and would make a mistake. However, the same operator has no hesitancy in inserting a short needle into the gum tissue around a tooth and injecting a quantity of solution as employed in the old way. The dentist should not hesitate to resort to the nerve blocking injections by the extraoral method if he understands each step of the technic. The writer has no more hesitancy in making a deep injection by the extraoral method than the mere inserting of a hypodermic needle into the arm for medicinal medication. This method has its indications and contraindications just the same as any other division of local anesthesia, and to accomplish the most from it the operator should utilize it to the best advantage, and use it in those cases in which it is indicated with just as much ease, and make the injections as accurately, as those under the intraoral method. Once the technic is mastered the operator will find the extraoral method of blocking just as easy to accomplish as the intraoral blocking. If the operator is thoroughly familiar with the technic of both extra- and intraoral methods, he can accomplish much more with block anesthesia, and such an application covers an immense field.

It has been the writer's pleasure to give instruction to a number of oral and dental surgeons, eye, ear, nose and throat specialists, who entered Army service, and block anesthesia in its different phases proved of great value in many operations, and the soldiers appreciated it. These operators were instructed first in anatomy. First, the osteology was given, followed by instruction on specially prepared wet anatomic specimens; underlying fundamentals of anesthetics; lectures on the allied medical subjects, followed by clinical instruction upon patients.

Indications for Extraoral Method

1. In case the operation involves an extensive area which can be blocked by anesthetizing, for example, the second and third divisions of the fifth cranial nerve.
2. In case considerable infection and pus are present within the oral cavity.
3. In case the tissues within the oral cavity are highly inflamed and swollen.
4. In case there is extensive trauma, laceration, gunshot or shell wound.
5. For the reduction of a fracture, bandaging and splinting if accompanied by inflammation, and infection.
6. For removal of necrosed bone.
7. In case the jaws can not be opened sufficiently wide to insert the needle by the intraoral method.
8. For the removal of tumors which involve an extensive area.
9. The extraoral method is valuable many times for operative dentistry, as, for example, the blocking of the anterior superior dental, superior labial, lateral nasal and inferior palpebral nerves at the infraorbital foramen, the posterior superior dental branch, etc.

CHAPTER XIII

BLOCK ANESTHESIA; INDICATIONS AND CONTRAINDICATIONS; PRECAUTIONS NECESSARY WHILE OPERATING UNDER BLOCK ANESTHESIA

It is the duty of the general surgeon, oral surgeon, dentist, or professional anesthetist to select carefully the anesthetic or method to be employed in each individual case, and it must be remembered that in certain cases local anesthesia is contraindicated the same as general anesthesia. The oral surgeon or dentist, who desires to render the greatest service, should familiarize himself with all the different modern methods of producing both general and local anesthesia, and then employ these methods when they are indicated. When an operator takes this broad view of the subject of anesthesia he will render a greater service to humanity than the operator who tries to make all his patients adapt themselves to a single method. With the scientific administration of nitrous oxid-oxygen with a modern apparatus and through the medium of block anesthesia, practically all cases for oral surgery and dental operations can be successfully operated.

BLOCK ANESTHESIA; INDICATIONS AND ADVANTAGES

1. In case the administration of a general anesthetic is unusually difficult, as for operations upon the jaws, or plastic operations upon the face, wherein the proper nerve blocking injections are of great advantage.

2. In case no anesthetist is present to properly administer a general anesthetic.

3. In short, simple operations, local anesthesia is indicated over ether or chloroform anesthesia. However, if a general anesthetic be employed, nitrous oxid-oxygen is the general anesthetic of choice. In making this statement with reference to short operations, the reader must not be led to believe that block anesthesia is employed only for short operations, for such is not the case, as anesthesia can be maintained over a period of two or three hours, or even longer, if desired, the duration of the anesthesia being controlled by the vaso-constricting content of the injecting solution.

4. Local anesthesia is indicated in operations in which it is better to have a bloodless or almost bloodless field.

5. Local anesthesia is of great value to control postoperative pain within the operated part. Local anesthesia will block the postoperative pain or, at least, lessen it until the return of sensation. Quinin and urea are employed extensively for this purpose by some operators.

6. Block anesthesia is of great advantage in general and oral surgery operations to carry the patient over a number of painful postoperative hours into comfort.

7. Patients who have been operated under block anesthesia can in most instances be discharged immediately, provided the operation be a minor one.

8. When nerve blocking injections are made by skilled hands, with the proper quantity and percentage of solution injected, they are not associated with any grave danger, as is the case many times if a general anesthetic be employed. This is particularly true of ether and chloroform.

9. The surgical convalescence, general physical condition of the patient, and postoperative recovery are not so often disturbed as is the case in many instances following general anesthesia.

10. It is indicated in many cases in which it is possible to completely block all nerve communications to the part to be operated upon and render it completely insensitive.

11. It is indicated in those patients who possess a strong personal objection to the loss of consciousness.

12. In individuals who possess a tumor or growth, whereby a small section can be removed for microscopic examination, it is indicated, and many times the patients will submit to a much earlier operation under local anesthesia than if general anesthesia is employed.

13. The duration of anesthesia may be changed in accordance with the amount of the vaso-constricting agent employed. This is of great advantage for various prolonged oral surgery operations, such as the surgical removal of teeth, alveolectomy, reduction of a fracture, splinting, antrum cases, tonsillectomy, impacted third molars, etc.

14. The long duration of block anesthesia permits the operator to take his time with the operation which gives him the opportunity to utilize all of his skill while operating.

15. It is an advantage to the operator to have an open field during the operation, which is the case in block anesthesia, while with general anesthesia, many times, the anesthetic mask has to be reapplied, in order to keep the patient anesthetized for oral, throat, and plastic operations on the face. However, the reapplication of the anesthetic mask is not necessary when modern appliances are employed, as, for example, when the insufflation intratracheal tube or mouth tube are utilized.

16. Large or small areas may be anesthetized, depending upon the nerve or nerve branches blocked.

17. Anesthesia is secured of infected or inflamed areas by blocking the nerve branch in healthy tissue at a point distant from the operative field.

18. Intraoral nerve blocking injections, when skillfully made, are without pain because the needle is inserted into the mucous membrane and connective tissue. The extraoral injections can be made without any appreciable pain by making a preliminary injection into the skin with a fine sharp needle.

19. One or two insertions of the needle will block an operative field, depending upon the nature of the operation and the area to be blocked.

20. **Cooperation of the Patient.**—It is well known that this is of material advantage to the operator because he can operate with ease, and complete the operation with a minimum amount of laceration and without the inspiration of blood and mucus.

21. **Safety.**--Nerve blocking, when properly executed, is in most cases safer than any general anesthetic where a deep, prolonged anesthesia is required.

22. **Control.**--The operator has a certain amount of control over his anesthesia by injecting the proper amount. He also has control of the specific gravity, the isotonicity of the solution, and the amount of the vaso-constricting agent to prevent too rapid absorption.

23. **Simplicity.**—Various nerve blocking injections, both extraoral and intraoral, can be easily made, provided the operator is thoroughly familiar with his anatomy and the technic of injections.

24. **Efficiency.**—In many cases operations coming under the domain of the oral and dental surgeon can be performed successfully under some form of local anesthesia, provided the injections have been properly made. However, in many cases nitrous oxid-oxygen anesthesia is preferable.

25. **After-Effects.**—Patients who have been operated upon under nerve blocking seldom suffer any postoperative effects, such as headaches, nausea, retching or vomiting. This is of exceptional value in case the patient has been operated upon for fracture of the jaw.

26. **Complications.**—No complications follow the operation as a result of block anesthesia injections, such as pneumonia, or renal conditions, hence it is most desirable in the aged.

27. **Effect on Immunity.**—Ether or chloroform anesthesia greatly reduces the patient's resistance against pyogenic bacteria and pneumococci, which is avoided in local anesthesia.

28. The cost of producing block anesthesia is far less than that of any known general anesthetic.

29. If the part has been completely blocked, no traumatic surgical shock is produced.

30. If it is employed in septic cases the action on the human organism and the elimination from the system are far less than from the general anesthetic, such as ether and chloroform.

31. Local anesthesia lessens the possibility of the patient swallowing blood and mucus during an oral operation.

32. The patient can cooperate with the operator and assist with the operation.

33. The tissues can be handled more carefully, thereby lessening the amount of trauma and laceration.

34. Nerve blocking, when combined with general anesthesia plus other factors, blocks all afferent impulses, thus bringing about anoci-association. Nerve blocking is one of the important steps in producing anoci-association.

35. Nerve blocking prevents all reflexes from reaching contiguous parts or painful impulses originating at the site of operation, thereby causing less after-action.

36. The preoperative preparation of the patient is not so important for nerve blocking for oral surgery cases, as is the case for general anesthesia.

37. When a patient has been operated upon successfully under block anesthesia, as a rule, he, or she, as the case may be, will readily submit to future operations because confidence has been gained, and such patients are aware of the fact that they can be operated upon without suffering pain, and yet remain conscious.

38. Nerve blocking is a convenient method to be used at the bedside of a patient in the hospital or home.

39. It elevates dentistry and makes better oral surgeons and dentists, because with pain eliminated a better service will be rendered.

BLOCK ANESTHESIA: CONTRAINDICATIONS AND DISADVANTAGES

Block anesthesia is contraindicated for certain operations and with certain individuals. These contraindications and disadvantages may be summed up as follows:

1. With young children, unless the confidence of these little patients can be secured.

2. On patients suffering from epilepsy.

3. Upon highly neurotic or nervous individuals whose confidence cannot be obtained.

4. For operation of a part whose nerve supply it is impossible to block without inserting the needle into inflamed or infected tissue. If the needle is inserted through infected tissue it is liable to inoculate healthy tissue.

5. In case the patient is suffering intense pain caused by some pathologic condition, local anesthesia should not be employed unless a preliminary sedative is given. In most cases general anesthesia is indicated.

6. Local anesthesia is contraindicated with tissues of low vitality. The additional trauma caused by injecting the solution may still lower the tissue vitality. On the other hand, the low vitality of the patient may contraindicate general anesthesia; therefore, after all, local anesthesia may be the method of choice.

7. With patients suffering from severe heart lesions, such as aortic or mitral regurgitation, myocarditis, with threatened dilatation, or in individuals possessing a broken compensation, or in extreme cases of arteriosclerosis, with increased blood pressure, local anesthesia should be used with caution. In case local anesthesia is employed, the solution should contain a smaller

amount of the vaso-constricting agent, epinephrin, than the solution for the healthy individual. In many of these cases block anesthesia is safer than a general anesthetic, when produced by skilled hands, slowly injecting the proper percentage and quantity of solution. With these patients local anesthetics should be given with caution.

8. When the patient has a strong personal objection or dislike to remaining conscious during the operation.

9. A patient who is anemic, possessing a lowered vitality and resistance, who is very apprehensive, often suffers mental strain, and yet free from actual pain, may pass into a stage of syncope or collapse. Local anesthesia with these individuals should be given with caution.

10. A patient who has suffered considerably with some severe pathologic condition, and may be in a state of general infection, is not by any means the ideal patient for nerve blocking for the performance of a severe or prolonged operation.

11. Operations performed under nerve blocking upon pregnant women should be given the greatest consideration, avoiding all pain and mental excitement. When this is done they are ideal patients for block anesthesia.

12. If the operator is unable to vouch for the purity of the injecting solution, or the asepsis and thorough cleanliness of the apparatus, or if he is not positive he is familiar with the technic, local anesthesia is certainly contraindicated.

13. One of the greatest disadvantages of block anesthesia is the psychic effect produced upon the patient. As the patient is conscious, he is aware of everything that is going on about the operation and can hear the conversation between the operator and his assistant; therefore, nerve blocking inhibits physical pain but does not eliminate psychic fear and strain which are removed under general anesthesia.

14. Local anesthesia should not be used for the removal of a malignant tumor unless the operator is positive it is restricted to a small circumscribed area. If the operator is doubtful as to its limitations, the operation may extend beyond the area anesthetized and into tissue which would be difficult or impossible to further block with a local anesthetic, and after all one may have to resort to a general anesthetic.

15. Local anesthesia should not be used on individuals for operations of such a nature that they will demand a very large quantity of the solution. The patient should never be subjected to an enormous quantity of solution, especially if his physical condition contraindicates such a procedure. Nitrous oxid-oxygen should be administered.

16. Injection of the solution may cause circulatory disturbances and faintness, which may be due partly to the patient's apprehension, although the patient in most cases blames the drug that is injected.

PRECAUTIONS NECESSARY WHILE OPERATING UNDER BLOCK ANESTHESIA

The writer wishes to impress the operator, who has had little or no experience in operating under block anesthesia, with the importance of exercising care during the performance of certain operations. An operator may unthinkingly overlook some important factors and as a result may cause postoperative complications. The operator must always remember that the tooth or part operated is blocked as far as pain is concerned; therefore, he must ever be on his guard, especially in operative dentistry. In the grinding and shaping of a tooth for a crown or bridge abutment, the revolving stone must not be held in contact too long with the tooth structure for fear of generating heat which would have a destructive action upon the life of the pulp. The stone should be held in contact with the tooth for only a few seconds at a time, and during such a procedure it is advisable to keep a stream of cold air or water in contact with the stone and tooth.

Another instance in which care must be taken is in cavity preparation, especially for the young individual. The best of operators will occasionally expose the pulp even if no anesthetic is employed; to make an exposure therefore, if the tooth is blocked and is insensitive to pain, it is very easy with a sharp chisel or bur. The age of the patient, the anatomy of the tooth, the depth of the cavity, and the possible amount of pulp recession, with the formation of secondary dentin, must always be considered. In excavating deep cavities, great care should be taken in order to prevent pulp exposure unless such a procedure is desired by the operator. A deep cavity which has been prepared under a local anesthetic should never be filled immediately, or, in other words, while the nerve supply to the tooth is blocked, unless the operator takes due precaution in the placing of a base which is a nonconductor. If the operator is in doubt as to the close proximity of the cavity to the pulp, he should insert some soothing dressing, such as phenol, then carefully seal the cavity, and when the patient returns for the next sitting carefully examine the cavity before inserting the permanent filling. Gutta percha or temporary stopping only should not be placed in cavities which may prove hypersensitive after the anesthesia disappears without first inserting a soothing dressing. Due caution should be observed in forcing the rubber dam clamp or the ligature upon the delicate gingival tissue and peridental membrane. Injury can be easily produced to these tissues while the part is blocked. The separation of teeth by the mechanical separator, if not slowly and cautiously done, may result in the death of a pulp, fracture of a tooth, or cause extreme postoperative soreness. The testing out of the area blocked to ascertain whether or not deep anesthesia has been secured prior to operating should be carefully done. A lancet or other sharp instrument should not be forced into the peridental membrane unless the tooth or teeth are to be extracted. In testing out the teeth for operative dentistry, such as shaping them for abutments, pulp removal, cavity preparation, etc., sharp pressure can be exerted upon the gum tissue near the position occupied by the apex of the tooth with some blunt instrument, such as foil carriers, or operating can be cautiously started. Upon the first intimation that pain is being inflicted, it should prove to the operator that the part is not completely blocked which will necessitate his waiting a few minutes longer in order to give the anesthetic more time to produce deeper anesthesia, or that the solution has been improperly injected.

There are some operators who contend that the use of a pain relieving agent for sensitive cavity preparation is not justified, inasmuch as it takes away the pain factor which is a valuable aid in enabling the operator to know how near he has approached the pulp. However, in the opinion of the writer, this argument does not always hold good, for the reason that a certain percentage of pulps die in cases where no pain relieving agent has been employed. Block anesthesia is the method for the careful operator and not for the one who disregards thoroughness for speed. More care should be exercised while preparing cavities or shaping teeth for bridge work under anesthesia than without it. Modern and efficient methods for the alleviation of pain are at the service of every operator, and he who accepts and masters them will reap the reward and will be repaid many times in satisfaction for the time and energy consumed in diligent study. We are always justified in employing a pain relieving agent in those cases in which pain is inflicted, be it during cavity preparation or any other operation. The easiest way to earn gratitude is to relieve pain.

CHAPTER XIV

LOCAL ANESTHETIC DRUGS: THEIR COMBINATIONS AND USES

Acoin.—This is a local anesthetic which is known chemically as Di-para-anisyl-monophenetyl-guanidin hydrochlorid, with a formula of

$$\begin{array}{r l} NH< & \underline{\qquad\qquad\qquad\qquad}>OCH_3.\ \ HCl \\ C:N< & \underline{\qquad\qquad\qquad\qquad}>OC_2H_5 \\ NH< & \underline{\qquad\qquad\qquad\qquad}>OCH_3 \end{array}$$

Acoin has been employed as a local anesthetic in dentistry and ophthalmology, and has also been used in Schleich's infiltration anesthesia method. It is a white crystalline powder, with a fusing point of 176° F. It is readily soluble in water, and is said to be not only an anesthetic but an antiseptic. A solution of high percentage, when injected, will produce sloughing, and such a solution is contraindicated for hypodermic injections. However, a one per cent solution or less will produce anesthesia and can be injected without toxic results.

Allocain.—This is a compound which contains alypin and procain in combination with synthetic suprarenin and thymol.

Alvatunder.—This is a local anesthetic solution which is used in dentistry and is said to contain the following:

	Gm. or Mil	
Cocain hydrochlorid	1	
Phenol		15
Tincture of iodin (decolorized)		15
Glycerin	10	
Water q. s. ad.	100	

Alypin.—Alypin is the chlorid of the benzoyl-ethyl-tetra-methyl-diamino derivative of secondary propyl alcohol and having a formula of

$$CH_3\ CH_2\ C\ (C_6H_5COO)\ \ ((CH_2N(CH_3)_2)\ \ CH_2N\ (CH_3)_2\ HCl.$$

This drug is synthetically prepared and is closely related to stovain. It is a white crystalline powder and has a melting point of 169° C., and is very soluble in both water and alcohol. When added to water, it makes a neutral solution and can be boiled for a period of five minutes for the purpose of sterilization without danger of decomposition. It has a bitter taste. It is said that two, three, or four per cent solutions are stable, and that a solution weaker than two per cent may become disintegrated and decomposed. It should be kept excluded from light and air. Its presence can be protected in solution by adding potassium iodid, which renders a white precipitate, while potassium dichromate added to the solution will produce a yellow precipitate which is readily soluble in hydrochloric acid.

Action and Uses of Alypin.—It is a local anesthetic and is safer than cocain, and is without mydriatic action. It is claimed that its anesthetic power is equal to that of cocain, but as previously remarked, it is believed not to produce disturbance of accommodation, and to be far less toxic than cocain. The duration of anesthesia however, produced by alypin is considerably less than that produced by cocain. It is an irritant to the tissues and may cause a good deal of postoperative pain, and when used in from three to five per cent solution it may cause sloughing and necrosis. When suprarenal extract is added to a solution of alypin, the latter tends to neutralize the vaso-constricting properties of the former drug. It has been used quite extensively in the practice of ophthalmology, general surgery, ear, nose and throat work, as well as in the practice of dentistry. The solution should be freshly prepared, and the vehicle should be thoroughly sterilized over the flame for several minutes. The alypin is then added, and the boiling is continued from one to two minutes. Schleich tells us that alypin added to cocain, when injected by the infiltration method, permits a larger quantity of the solution to be injected, and the three following formulas are according to Schleich:

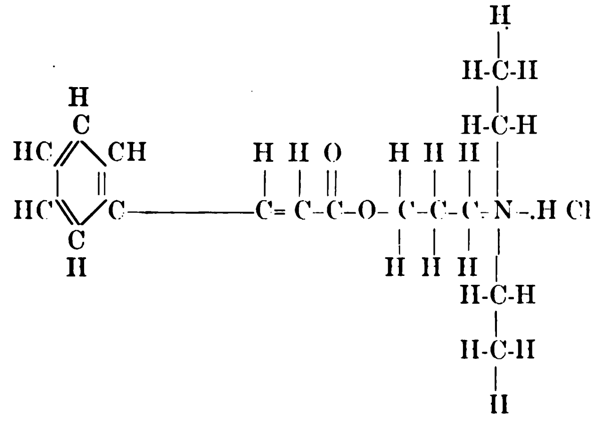
	Gm. or Mil	
1. Alypin		1
Cocain		1
Sodium chlorid		2
Distilled H_2O	100	

	Gm. or Mil	
2. Alypin		05
Cocain		05
Sodium chlorid		2
Distilled H_2O	100	

	Gm. or Mil	
3. Alypin		01
Cocain		01
Sodium chlorid		2
Distilled H_2O	100	

Dosage.—It is injected hypodermically in from one to four per cent solution. It is applied to the eye in one to two per cent solution. It is used externally in from ten to fifteen per cent solution. Seven mils of a two per cent solution have been used without toxic results. Tablets can be obtained containing various amounts of the drug.

Apothesin.--This is a new synthetic product of American origin and is compounded by an American pharmaceutical concern. It should be gratifying to the profession to see what great strides have been made in synthetic chemistry by American chemists in the last few years, and this is one of the new drugs which has been prepared. Apothesin is known chemically as the cinnamicester of gamma-diethyl-amino-propyl alcohol hydrochlorid, with the following formula:



The manufacture of synthetic drugs by American chemists, such as apothesin, and recently procain, places the profession in a position to be independent of foreign supplies, of which we have partaken so liberally in the past.

Apothesin occurs in small white crystals, having a melting point of 137° C. It is highly soluble in water and readily soluble in alcohol, and slightly soluble in ether and acetone. A solution of apothesin is neutral to litmus and is precipitated from solution by the ordinary alkaloidal and alkali reagents. The best results are obtained when the solution is freshly prepared from the tablet. The solution is quite stable and will keep indefinitely if protected from contamination. Solutions can be sterilized by boiling for several minutes in the usual way.

Physiologic Action.—The author has employed this drug in a large number of nerve blocking injections for oral surgery, and has carried out experimental work with it, but can only speak of his findings up to the present time as his investigations are not yet complete. It seems that in medicinal amounts it has little or no effect on the circulation or respiration, and from observations so far made it has a much lower toxicity than cocain. When this drug is instilled into the eye it does not affect accommodation, neither does it produce mydriasis nor increase intraocular pressure. It is not a habit-forming drug.

To summarize: It can be said that:

1. It dissolves readily in alcohol and water.
2. It forms neutral solutions.
3. It can be sterilized by boiling.
4. It can be combined with the suprarenal extract, etc.
5. It is less toxic than cocain.
6. It is not a habit-forming drug.

Dosage.—1. For general surgery it can be used in .25 to 2 per cent solution. 2. For anoci-association by the Crile method, a .25 per cent solution will suffice. 3. In rhinolaryngology, 5 to 10 per cent solution. 4. In the practice of ophthalmology, it may be used in from 1 to 10 per cent solution when employed for topical applications. 5. For oral and dental surgery nerve blocking, it may be used in from 1 to 2 per cent solution.

Note.—Apothesin is used with or without the addition of adrenalin, although in most cases adrenalin is added, which not only intensifies the action of the anesthetic but prolongs the period of anesthesia. The duration of the anesthesia is governed by the amount of adrenalin contained in the injecting solution.

For experimental work with apothesin, see Chapter XVII on "Comparative Action of Various Local Anesthetic Agents" (page 283).

Anesthesin.—This is ethyl-para-amidobenzoate having a chemical formula as follows:

$$NH_2 C_6 H_4 .COOC_2 H_5$$

This drug was introduced as a substitute for cocain, and is a white crystalline powder without odor or taste, soluble in alcohol, but only slightly soluble in water. It is prepared by reducing ethyl-para-nitro-benzoate with hydrochloric acid and zinc. It has a melting point of 90° C. In addition to being soluble in alcohol, it is also soluble in benzene and ether.

Action and Uses.—It is used as a local anesthetic, and experimental research has shown it is nontoxic in therapeutic doses. It is also employed internally in the treatment of gastralgia in doses of from five to eight grains. It is used considerably as a dusting powder, and it is said that the physiologic activity of this drug is equal to that of orthoform. It is free from any irritating or toxic action. Anesthesin can be applied to delicate tissues without fear of producing irritation, and has the power to render nerve tissue insensible to pain when it comes in contact with it, and many claim it is superior to orthoform in its effect. It has an anesthetic action, but does not produce as deep anesthesia as cocain, and it does not possess the power of penetrating the mucous tissue like cocain. Anesthesin being insoluble in water, its use as a hypodermic injection is prohibited, thereby restricting it to be used in the form of direct application to the part.

Anesthol.—This is a local anesthetic which is in a liquid state and possesses a very bitter taste, and has the odor of ether. It was used several years ago in dental practice in Europe.

Anestheticum.—This is a local anesthetic which has been used in dental practice and is supposed to be a compound consisting of cocain in ten per cent strength in phenyl acetate.

Anaezol.—This is a preparation which contains a number of ingredients and is used as a local anesthetic. In addition to its anesthetizing power, it is also antiseptic. It contains the following: cocain, boric acid, glycerin, indigo, oil of wintergreen, oil of eucalyptus, thymol, alcohol, menthol, benzoic acid, and phenol.

Andolin.—This is a local anesthetic solution which is used in dental practice, especially in Europe, and does not contain cocain. It has the following formula:

	Gm. or Mil	
Eucain B.		5
Stovain		75
Suprarenin		008
Physiological salt solution q.s. ad	100	

Analgos.—This compound contains a number of ingredients and is a local anesthetic used in dentistry. It has the following formula:

	Gm. or Mil	
Phenol		
Thymol		
Menthol		
Aspirin		
Sodium chlorid,	āā 1	
Cocain hydrochlorid		5
Alcoholis dilutum	95	

Anesthaine.—This is a local anesthetic solution which is ready to use and contains stovain, antiseptics and water.

Antipyrin.—This is phenyl-dimethyl-pyrazolon phenazone, and possesses some anesthetic power, but it does not produce as deep anesthesia as cocain, and is less toxic, according to Heineck. This author also states that antipyrin is valuable in obtaining anesthesia of the bladder. It has also been used considerably by Lydston as a local anesthetic in genitourinary diseases.

Benesol.—This is a local anesthetic combination consisting of cocain hydrochlorid, phenol, eucain-B, menthol, amyl nitrite, eucalyptol, and sterile distilled water. This combination has been used as a local anesthetic in dentistry.

Bonainsche Mixture.—This local anesthetic mixture contains equal parts of phenol, cocain hydrochlorid, and menthol, and in addition a small percentage of adrenalin hydrochlorid.

Braun's Formulas.—The four following formulæ, all of which contain cocain, have been recommended by Braun:

		Gm. or Mil	
1. ℞	Cocain hydrochlorid		1
	Suprarenin 1 per cent solution		3
	Physiologic salt solution	100	
2. ℞	Cocain hydrochlorid		1
	Suprarenin one per cent solution		3
	Physiologic salt solution	50	
3. ℞	Cocain hydrochlorid		05
	Suprarenin one per cent solution		6
	Physiologic salt solution	10	
4. ℞	Cocain hydrochlorid		05
	Suprarenin one per cent solution		6
	Physiologic salt solution	5	

Braun's Tablets.—These tablets are used for producing local anesthesia in dentistry, and the formula is as follows:

		Gm. or Mil	
℞	Cocain hydrochlorid		01
	Suprarenin borate		00013
	Sodium chlorid		009

Bunte-Moral's Local Anesthetic Combination.—The formula is as follows:

		Gm. or Mil	
℞	Procain	1	50
	Sodium chlorid		92
	Thymol		02
	Distilled H_2O, q.s. ad.	100	

Add one minim 1:1000 solution suprarenal extract to each mil.

Phenol.—Phenol is not only an escharotic but an anesthetic, and is used in many local anesthetic combinations. It is added many times to the various combinations not only for its slight anesthetic properties but as a preservative. Phenol is known chemically as ethyl-hydroxid, and has a chemical formula of C_6H_5OH.

It is made synthetically, and is also derived from coal tar by distillation. It has a melting point of 40 C., and is a colorless crystal-shaped mass. It has a burning, sweetish taste and is very deliquescent in air. With age it assumes a pinkish color which does not, however, indicate impurity, and does not affect its medicinal action. It coagulates albumin and is readily soluble in glycerin. It is soluble one in twenty parts of water. It is employed many times by the dermatologists to relieve itching, and in one per cent strength in ointments. A solution of 1 to 850 parts water, will prevent the multiplication of bacteria.

Chlcretone (Chlorbutanol); Aneson; Anesin.—Chloretone is produced by the reaction of acetone on chloroform, and has a chemical formula of

$$CCl_3.C(OH).CH_2CH_3$$

This agent is a local anesthetic and possesses a weaker action than cocain, and in addition to its local anesthetic action, it is an internal hypnotic. It is said that it possesses the strength of boric acid as an antiseptic. It exists in the form of crystals and resembles camphor somewhat in taste. It is only slightly soluble in water but freely soluble in glycerin and alcohol. It acts somewhat similar to chloral upon the central nervous system and is claimed not to affect the circulation or respiration. Its local anesthetic action takes much longer to develop than that of cocain hydrochlorid.

Considerable stress has been laid upon the value of this drug as a sedative and hypnotic. It is not a habit-forming drug. It is used in many local anesthetic solutions, not only for its anesthetic power but as a preservative. It is also employed in the treatment of insomnia, in vomiting in spasmodic conditions, and also as an introductory to general anesthesia, as it reduces excitement and allays or prevents nausea.

Dosage.—It can be used hypodermically as a local anesthetic in a saturated solution. Internally the dosage is from five to twenty grains.

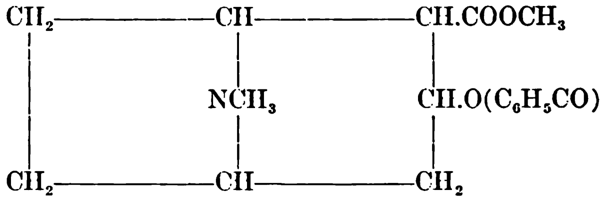
COCAIN

Origin and Introduction.—The alkaloid cocain, which is obtained from the coca plant, called the erythroxylon coca, is one of the oldest anesthetics in use. The action of the coca plant is numbing or paralyzing, and has been known for several hundred years. The history of cocain has already been covered in detail in connection with the history on anesthesia, and the writer refers the reader to that part of the text. However, it might be well to state here that the small green leaves of the erythroxylon coca plant are gathered and dried, and it is from these leaves the alkaloid cocain is obtained.

In the year 1860 Niemann and others published literature with reference to the anesthetic properties of cocain, but it was Koller in 1884 who introduced it as a valuable adjunct in surgery. Among Koller's first operations cocain was used in his practice of ophthalmology. After Koller introduced it to the medical profession, the report of its use and action soon spread throughout the world. The discovery of this drug and its action, as a local anesthetic, proved to be the basis of local anesthesia. This drug is recognized as the king of all local anesthetics when it comes to rapidity and intensity in the production of local anesthesia. The introduction of cocain to the medical and dental professions was a stepping stone toward greater things. It has served a most valuable purpose in allaying or blocking the sensibility to pain during operations, but the toxic properties which it possesses caused numerous research workers to search for a drug which was endowed with anesthetic properties similar to those of cocain, but yet free from producing severe toxic symptoms. Numerous research workers have contributed to this important link in anesthesia, and in modern times several local anesthetic drugs have been discovered and presented to the medical and dental professions which answer the same purpose as that of cocain, and are far less dangerous, among which we may mention procain, apothesin, quinin and urea, and several others which will be found elsewhere in the text.

Cocain has played a very important part in local anesthesia ever since its discovery, and it has been the basis of practically all the local anesthetic tablets and solutions offered to the profession, but has gradually been discarded for local anesthetic agents which are not nearly so toxic. Very few practitioners are employing cocain today, and in the writer's opinion the time is not far distant when those few practitioners who are now using it will employ it far less or totally discard it. Cocain has served its day, and there is absolutely no reason why it should be employed when we have at our disposal more efficient compounds. Cocain is not only a treacherous drug but a protoplasmic poison. It is extremely difficult to judge the dosage which different patients can tolerate without displaying toxic symptoms, in *view of the fact that many people possess an idiosyncrasy for it.* When we consider the large quantity of solution necessary to block various nerve trunks, one would not dare to inject a solution of cocain in the same manner as he would such anesthetics as procain, apothesin, quinin and urea, etc. When we inject a solution for the purpose of blocking a nerve trunk, it is quite different from injecting a small quantity of the solution around a tooth in the gum tissue or peridental membrane, for the reason that more solution is required to block nerve trunks than is necessary by the submucous method. Furthermore, when the solution is injected at a distant point from the field of operation, as is the case with nerve blocking, all the drug is absorbed and enters the circulation; whereas, if the solution is injected by the submucous or peridental method, less quantity of the drug is absorbed on account of the injection being made at the site of operation, and some of it is lost in the hemorrhage.

Chemistry; Physical Properties; Compounds.—Cocain is an alkaloid obtained from the erythroxylon coca. Its chemical name is benzoyl-ecgonin-methyl-ester with the following formula:



It consists of colorless prismatic crystals having a fusing point of 98° C. It appears in large colorless prisms possessing a bitter taste, and producing first a tingling, later followed by profound numbness of the tongue. The alkaloid cocain is soluble in 1 in 600 parts water; therefore, the alkaloid itself is used very little for medicinal purposes. It benumbs the sense of taste, inhibits pain, but the sense for heat and cold is not diminished. Stock solutions containing cocain do not keep well and in time will disintegrate.

Many unethical secret preparations have been placed on the market, and in many cases cocain has been the local anesthetic employed, but the advent of the Harrison Federal Antinarcotic Law has put a stop to such practice. Stock solutions can be preserved by adding one per cent of boric acid or one-tenth per cent of salicylic acid, or 1/4 to 1/2 per cent chloretone, or by employing camphor water as the vehicle. When stock solutions are kept on hand, or when a solution which contains cocain is boiled, it breaks up into methyl alcohol, benzoic acid and ecgonin, as is illustrated in the following formula:

$$\underset{\text{Cocain}}{C_{17}H_{21}NO_4} + 2H_2O = \underset{\text{Ecgonin}}{C_9H_{15}NO_3} + \underset{\text{Methyl alcohol}}{CH_3OH} + \underset{\text{Benzoic acid}}{C_6H_5COOH}$$

It will be seen from the above formula that it would be unwise to inject a stock solution containing cocain or to subject the solution to boiling. This being the case, it adds greatly to the inferiority of cocain as a local anesthetic, for the reason that a freshly prepared solution made from tablets cannot be boiled to insure alsolute sterility. The alkaloid cocain, as previously pointed out, is only slightly soluble in water; therefore, salts of the alkaloid are employed, and the compound which is generally selected is cocain hydrochlorid, which is soluble in one-half part of water; it is also soluble in alcohol, chloroform, and glycerin. The hydrochlorid appears in colorless, transparent crystals or a white crystalline powder, which possesses a slightly bitter taste, is odorless, and resembles the alkaloid cocain in producing a tingling sensation when applied to the tongue, which is quickly followed by profound numbness of several minutes' duration. It is also permanent in the air, thus retaining its natural color. Cocain hydrochlorid is the compound usually selected for hypodermic injections, if cocain is the local anesthetic to be employed.

Tests.—The operator can make the following tests very easily, which will enable him to detect the presence of cocain in any solution which contains it.

1. Take a test tube containing one mil of the suspected solution, and add five minims of a picric acid solution, which will give a yellow precipitate, if cocain is present.

2. Place one mil of the suspected solution in a test tube and add a few minims of iodin, which has been dissolved in potassium iodid solution, and it will give a red precipitate if cocain is present.

3. A third test is to boil the suspected solution in a test tube for several minutes with sulphuric acid, then neutralize with the hydroxid of potassium, and then add a few minims of ferric chlorid, and if cocain is present, ferric benzoate is precipitated, which is a brownish yellow.

Alkalies produce a white precipitate which is soluble in ether or alcohol.

Physiologic Action and Uses.—Cocain paralyzes the terminal nerves when it is applied directly to or injected in or near nerve tissue, producing a loss of sensation and causing an area of ischemia which is brought about by the vasoconstriction of the arterioles. When it is applied to the mucous membrane, the membrane immediately assumes a pale condition from the constriction of the blood vessels. This constriction, however, lasts for a short period and is followed by vaso-dilatation. When the local anesthetic solution containing cocain is injected by the perineural, endoneural or terminal method, the cocain has the power of producing a blocking of the sensory nerve fibers so as to inhibit afferent sensory impulses from reaching the brain. It is a mydriatic which acts both centrally and locally, and the dilatation which is produced is not so pronounced as that produced by atropin, and the reaction to light is not abolished. When cocain is taken into the system it first produces stimulation, which is followed later by depression of the nervous system, first affecting the brain, and gradually extending to the spinal cord and medulla. In most cases the spinal cord is not stimulated until the brain stimulation has subsided and a state of depression has supervened. On account of this fact, a combination of symptoms may be present, that is, both stimulating and depressing symptoms. Large doses result in incoherent speech and delirium, which may be followed by convulsions and coma. Additional doses of this drug cause an increase in the heart action and also in arterial pressure, while toxic doses bring about a slow, soft, weak or thready pulse, characterized by a very low arterial tension. The stimulation of the brain is manifested by increased psychic activity, loss of the sense of fatigue and insomnia, as well as muscular irritability.

Cocain has an almost universal action upon all tissue, that is first stimulating it, and later on causing a paralysis. When the salts of cocain are injected, they are almost immediately absorbed, or when cocain is applied to the mucous membrane it is taken up very quickly, thus entering the blood stream. It is not absorbed by the unbroken skin. In view of the fact that it is absorbed so quickly when applied to a mucous surface, we have the reason why so many cases of collapse follow its introduction. It not only possesses a marked action upon nerve tissue, but it also exerts a great influence upon other forms of protoplasm. This drug possesses a somewhat different action upon different individuals. With some people it first causes stimulation, causing them to laugh, sing, or possess great ideas and to express themselves freely with reference to the trials and tribulations of life. It decreases pain, and it is through this channel that people become addicted to the drug.

Its principal use in the practice of medicine and dentistry is that of a local anesthetic. It has been employed in the past, but not so much at the present time in ophthalmology, or by ear, nose and throat specialists. Some eye, ear, nose and throat specialists prefer this drug to its substitutes on account of the fact that it produces a much quicker and deeper anesthesia, but this one excellent feature is counterbalanced by a countless number of disadvantages. Excellent results can be obtained by the proper employment of procain, apothesin, and other local anesthetic agents in eye, ear, nose and throat surgery. There seems to be little ground for employing it at all in modern surgery. The promiscuous use of this drug, and in some cases even its restricted use, has led patients to become addicted to the habit of taking it. It is one of the most seductive of the drugs that are taken habitually, and its effects upon an individual are most appalling and disastrous. It is unwise to prescribe this drug for a patient to use at the home, whether it is employed internally, as a gargle, mouth wash or spray. When a five or ten per cent solution is applied to the mucous membrane of the mouth or nasal cavity, it produces very quickly anemia of the surface and, at the same time, the sensitiveness of the mucous membrane to pain is abolished to the extent of the penetration of the drug. Ophthalmologists apply it to the eye in from one to four per cent solution. It is applied to the mucous membrane of the soft palate and to the anterior and posterior pillars of the tonsils, by swabbing with a five or ten per cent solution, or in some cases the gauze on the applicator can be moistened in a solution of 1/1000 adrenalin hydrochlorid, and then passed in the cocain crystals and carried to the nasal mucous membrane or to the tonsillar region, and painted carefully upon the tissue. However, this is not to be recommended for use in a promiscuous way, for the reason that considerable cocain may be swallowed by the patient and toxic symptoms result. The moistening of the swab with a five or ten per cent solution of cocain, which contains sufficient adrenalin to cause vaso-constriction, is much better. Cocain packs are also used considerably by rhinologists for producing anesthesia of the nasal mucous membrane and bone. It is the writer's experience that excellent results can be secured by using procain in this manner for these operations, thereby eliminating to a great extent the toxic symptoms which many times follow the use of cocain.

Cocain is also used for its astringent action in treating acute cases of coryza or other inflammations in the nasal cavity, and nasal breathing is rendered easier by reducing the swollen tissue covering the nasal septum and turbinated bones.

The application of a cocain solution to ulcerated areas has been employed in the treatment of laryngeal tuberculosis or other throat affections, such as syphilis, which cause painful deglutition. However, in the treatment of these cases good results have been obtained by blocking the superior laryngeal nerves. It is likewise used as an antiemetic when vomiting is caused by local irritation.

The formulæ of the various tablets and solutions that are on the market will be found in Chapter XV.

The addition of adrenalin or synthetic suprarenin to a cocain solution greatly enhances the action of the cocain, and this is used for two reasons, *first*, that it causes a vaso-constriction of the arterioles locally, thus causing an area of ischemia, which greatly reduces the amount of hemorrhage, and, *second*, it materially lessens the activity of absorption of the anesthetic, which makes it safer.

Toxicity and Dosage.—The action of cocain upon the tissue is that of a protoplasmic poison, and one can not always judge the nontoxic dose, and its after-effects do not always depend upon the amount injected. Since suprarenal extract has been added to cocain solution, its toxic action has been greatly reduced, inasmuch as the epinephrin greatly reduces the amount required to produce anesthesia and, on the other hand, inhibits rapid absorption into the tissue. In other words, the vaso-constriction which has occurred causes the cocain to enter the system very slowly, thereby allowing a greater amount to be injected. *When a sufficient amount of the drug enters the blood stream, acute cocain poisoning is produced. Cocain is not only a treacherous drug, but a dangerous one, for the reason that its action upon various individuals varies so greatly. Some individuals can tolerate much more of the drug than others, but when it is injected into certain patients who are apparently able to tolerate the average dose, we are confronted by alarming symptoms of collapse a few moments following its injection. Many people possess an idiosyncrasy for this drug, and it should always be given with caution, even in apparently normal persons.*

Cocain poisoning manifests itself in many instances within a few moments, or even while the injection is being made. The patient becomes uneasy, restless, feels nauseated, presents an anemic appearance, with a marked fall in blood pressure, dilated pupils, clammy skin, cold perspiration, vertigo, muscular twitching which may be combined with convulsions, depressed respiratory movement, numbness, air hunger, visual hallucinations, a rapid, weak and thready pulse, syncope, coma and death.

The strength of the cocain solution employed in most cases varies from one-quarter to five per cent, the variation being in accordance with the rapidity of absorption and the degree of effect desired, and the total quantity administered should always be limited with due regard for safety. *The maximum quantity of this drug which is allowed to enter the circulation should never exceed one-quarter of a grain.* Even the injection of this amount has caused collapse hundreds of times, and it is in patients whom we least suspect that such undesirable results follow. One-quarter of a grain should be the limit in the routine use of cocain by hypodermic injections. However, if the solution is injected by the submucous or peridental method around the tooth and the tooth extracted, or if the operation should be upon tissues where incision will cause hemorrhage, a greater amount can be injected as some of the drug is lost in the hemorrhage. This drug is to be employed in dental practice, as a rule, in one per cent solution for hypodermic use. Wood reports the death of a girl, eleven years of age, which resulted in forty seconds following a hypodermic injection of twelve minims of a four per cent solution, which is equivalent to about one-half grain. Ivid reports a death which was caused by the application of twenty minims of a five per cent solution to the gum tissue. Frost reports a case in which one minim of a one per cent solution in the eye caused intense poisoning. Stevens reports a case in which four minims of a three and a half per cent solution caused violent convulsions. Numerous other deaths are on record as having been caused by this drug.

The author has had several cases in his own practice which developed alarming symptoms, and he has been called in on several occasions to assist fellow practitioners in the treatment of cases of shock and collapse following the injection of this drug.

It is true that idiosyncrasy must account for the occurrence of such cases. Knowing that many people possess this idiosyncrasy for cocain, it should stimulate us to be on the alert and to exercise the greatest care and discrimination in its employment. Perhaps it would be better not to employ it at all in these modern days, for the reason that there is really no excuse for using it. There are many ready made commercial solutions on the market, and it is safe to say that in many of them cocain is the basis of their formulas, and there is absolutely no good reason why any qualified practitioner should use any preparation unless he knows exactly what it contains. While we must admit that many of these local anesthetic solutions have merit, all ethical preparations should have the formula stamped thereon. This not only elevates the standing of the manufacturer in the eyes of the profession, but it places the dental practitioner on his guard should the formula contain a drug which is so toxic and powerful as that of cocain or its toxic substitutes. (For research work on local anesthetics, see Chapter XVII on "Comparative Action of Various Local Anesthetic Agents.")

Treatment.—The treatment of cocain poisoning will be found in Chapter XXXVI under collapse, shock, etc.

Codrenin.—The preparation put out under the name of *codrenin* contains cocain hydrochlorid as the anesthetic. Two different preparations are made and used for dental anesthesia. In addition to the cocain hydrochlorid, the solution contains adrenalin and chloretone, the latter being added as a preservative. It is marketed in glass stoppered bottles in two strengths, one containing two per cent of cocain hydrochlorid in adrenalin hydrochlorid, and 1/15,000 solution, and is preserved with chloretone; while the other solution contains one per cent of hydrochlorid in adrenalin-hydrochlorid 1/5,000 solution and is preserved with chloretone. It is stated that codrenin in stock solution is not permanent, but the adding of chloretone greatly assists in preventing rapid disintegration. The bottle containing this compound should be protected from the air which causes contamination and disintegration of its contents. When the compound turns dark red or brown, it should be discarded.

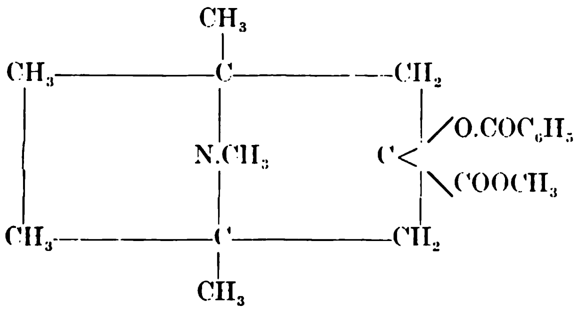
Conducto Tablets.—This is a local anesthetic tablet in which all the constituents have been scientifically combined, that is, the local anesthetic procain, the vaso-constricting agent, suprarenin, and Ringer's constituents which are sodium, calcium and potassium chlorids. This tablet renders an isotonic Ringer solution together with the suprarenin and anesthetic when added to sterile distilled water.

Dentalone.—This is a dental local anesthetic which is used especially for the treatment of exposed or irritated pulps, sensitive tooth sockets, sensitive dentin, etc. It contains thirty per cent of chloretone and has the following formula:

℞

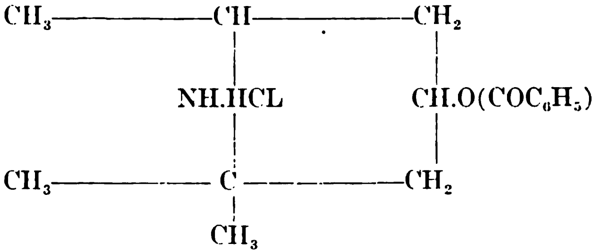
Oil of birch	12 minims
Oil of cinnamon	50 "
Oil of cloves	300 "
Chloretone	175 "

Eucain-A (Alpha Eucain).—This is a compound which is known chemically as benzoyl-methyl-tetra-oxy-piperidin-carboxylic-methyl-ester and its formula is:



The base-forming eucain-A is closely associated with that of cocain, and is used as a local anesthetic, is much cheaper than cocain, and is claimed to be a much safer drug. It is prepared synthetically and forms colorless prisms, and has a melting point of 104° C. The base eucain is almost insoluble in water, therefore the hydrochlorid is employed for hypodermic injections as a local anesthetic. The hydrochlorid is soluble in about one to ten parts water, and is not decomposed by heat during the process of sterilization. This product is superior to cocain, in that it can be boiled and produces almost as deep anesthesia as cocain, and is considered to be less toxic. It seems to have less toxic action than cocain upon the heart, but in many cases general toxic symptoms have developed which in certain respects resemble symptoms of strychnin poisoning. It is for this reason that many practitioners have preferred a much safer drug.

Eucain-B (Beta-Eucain).—This compound is known as Benzyl-vinyl, diacetone-alkamin-hydrochlorid, with the following formula:



Eucain-B is a white crystalline powder, having a melting point of 263° C. It is odorless, and is soluble in the following percentages in the various vehicles:

In water, 3.5 per cent.
Alcohol, 3.5 per cent.
Glycerin, 2.0 per cent.

Eucain-B does not produce as much irritation as eucain-A. Eucain-A was first prepared synthetically, but did not meet with very much favor on account of its irritating properties, and later on eucain-B was synthetically prepared, which was practically without irritating properties, was less toxic, and for a time was a very popular drug. The synthetic preparation of eucain was a decided advance in synthetic chemistry, for the reason that the profession was furnished with a drug that contained less toxic power than cocain.

After the discovery of beta eucain, the alpha cocain was discarded and its manufacture discontinued. The base which forms beta-eucain is practically insoluble in water, therefore the hydrochlorate is employed, and as will be seen from the above list of vehicles, it is soluble in water to an extent of 3.5 per cent. However, this was a disadvantage as stronger solutions were many times required before eucain lactate was manufactured, which is soluble in water to the extent of twenty-two per cent. Eucain lactate is a white powder and is endowed with a very bitter taste. Solutions of eucain lactate injected hypodermically for surgery are practically nonirritating to the tissues, but produce vaso-dilatation. It does not produce as deep anesthesia as cocain, besides the duration is shorter, even if suprarenal extract is added in the same amount with each drug.

Vinci has done a good deal of research work with this drug and claims it is one-third to one-fifth as toxic as cocain. Other research workers say it is one-half to one-third as toxic as cocain; all agree, however, that it does not possess the toxic power of cocain. The experience of the writer has been that beta-eucain solutions are much less toxic than cocain hydrochlorid solutions, and he has frequently injected as much as four grains of this drug for oral surgery operations, and has never observed the untoward and toxic symptoms, which have occurred when even a small amount of cocain has been injected in a number of cases.

Solutions of beta-eucain may be kept for several weeks without deterioration. The solution can be boiled, which is a great advantage. The vaso-dilatation of the arterioles caused by beta-eucain many times brings about an increased hemorrhage, and severe postoperative hemorrhage may ensue. This holds true, however, only when the drug itself is injected; but since the discovery of suprarenal extract, and when a proper amount has been added to the solution and injected, it overcomes this difficulty. This drug has never been used to any extent in the practice of ophthalmology, but it is employed considerably in operations for general and oral surgery and operative dentistry. It takes longer for it to anesthetize the tissue than procain or cocain, and it is used in a much weaker solution than procain. There is no question but what beta-eucain serves a good purpose and up to the time of the discovery of such agents as procain, apothesin, quinin and urea, it was no doubt the most satisfactory and the safest substitute for cocain. In brief, its advantages may be pointed out as follows: It is less toxic than cocain hydrochlorid. The duration of anesthesia is highly satisfactory, inasmuch as the anesthesia lasts much longer than a solution containing an equal amount of procain, and it possesses little or no irritating action upon the tissues, and the postoperative results in most cases are satisfactory.

The formula given below was at one time used quite extensively and is recommended by Braun:

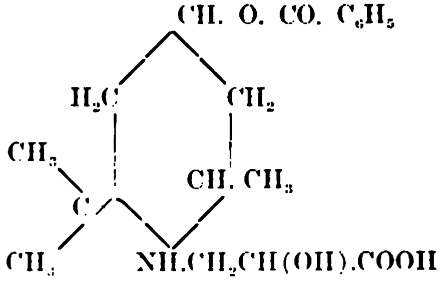
	Gm. or Mil	
℞		
Sodium chlorid	0	2
Eucain beta	0	8
Distilled water	100	

It will be found that a one-half per cent solution of beta-eucain is sufficient for such operations as are done in connection with oral surgery, dentistry, and for such general surgical operations as appendicitis, hernia, etc.

Eucain Lactate.—This synthetic anesthetic preparation is far more soluble in water than either eucain-A or eucain-B and, at the same time, possesses all the other properties of beta-eucain hydrochlorid. It has the following solubility at ordinary temperature:

When dissolved in water....................	22 per cent.
" " " alcohol..................	11 per cent.

Eucain lactate has the following formula:



When this white crystalline powder is dissolved in water it renders the solution alkaline. It is claimed that this compound is a nonirritant to the tissue and is recommended to be used in the following percentage solutions:

Local anesthesia in dentistry (block anesthesia),	1 to 2 per cent sol.
For surgery of ear, nose, and throat,	5 " 12 " " "
For ophthalmic surgery,	1 " 3 " " "
Infiltration or terminal anesthesia,	.1 " .5 " " "

Eucain lactate is preferable to eucain-B, not only because of its greater solubility, but in view of the fact that it does not cause tissue irritation, and last, but not least, it possesses all the anesthetic properties of beta-eucain hydrochlorid. This anesthetic should be injected in an isotonic vehicle, which conforms to physiologic laws and functions of the living cell.

Eudrenin.—This local anesthetic at one time was used to some extent in dental practice. It was dispensed in ampules containing one mil which was used by the hypodermic method. Each ampule contained the following:

Beta-eucain hydrochlorid	0.0025 gm.
Adrenalin chlorid	0.0001 "
Physiologic saline solution	1. "

The adrenalin chlorid employed is the 1:10,000 solution.

Euroform Paste.—This is an efficient dental anodyne and is used for wound packing in such operations as are followed by postoperative pain caused by laceration of the tissues and exposure of the alveolar process following the extraction of teeth or other oral operations. Many times, following such operations the terminal nerve endings are exposed, and when this is the case the patient suffers excruciating pain. This compound is not only used as a palliative measure, but it also stimulates healing as the preparation contains iodin which stimulates cell repair. On the other hand, the orthoform which it contains produces a slight local anesthesia which lasts for several hours following the application of the drug. It is applied by saturating sterile gauze with the paste and packing it into the tooth socket. It should not be left longer than twenty-four hours.

Euroform paste consists of the following, which is the formula of Dr. J. P. Buckley:

℞	Orthoform	ʒ i
	Petronol	ʒ iiss
	Europhen	ʒ iss
	White petrolatum	ʒ iiss

Holocain Hydrochlorid.—This drug is not only a local anesthetic, but an antiseptic, and with this added property its solution will keep indefinitely. It is a synthetic preparation and was introduced to the profession in 1897. Investigations of this drug were made in the Johns Hopkins Hospital, in order to determine its antiseptic value, and it was found that it exerted a distinct antiseptic power upon ordinary pus-producing bacteria, and it was also found that these bacteria lost their vitality at the end of twenty-four hours when injected with a one per cent solution, and yet the same pus-producing organisms, when placed upon agar, were able to grow when subjected to a five per cent solution of holocain. Its source is similar to that of phenacetin, and many times the compound holocain has been contaminated with phenacetin.

This compound occurs in colorless crystals, neutral or slightly alkaline, melting at 189° C. It is slightly bitter, odorless, and produces numbness when applied to the tongue. It is soluble in fifty parts of water, and when boiled in a glass vessel, which contains alkali, the solution becomes turbid, owing to the elimination of the free base which is alkaline in reaction.

Holocain is a local anesthetic very much like cocain, in that it produces a quicker anesthesia than cocain, and in addition is slightly antiseptic. It causes irritation of the tissues and is, therefore, rarely used for local anesthesia, with the exception of ophthalmic surgery. It is applied to the eye in one per cent strength, which is quickly followed by a burning sensation, and later causes anesthesia that continues about twenty-five minutes. It is particularly valuable in the practice of ophthalmology on account of its antiseptic properties, and in addition, it does not seem to affect the circulation, nor does it produce mydriasis as does cocain. It might also be remarked that it does not cause intraocular pressure or impair accommodation. Its properties, therefore, make it more valuable to use in the practice of ophthalmology than cocain. It is well to remember that when cocain is applied to the eye it causes a slight vaso-constriction by which hemorrhage is controlled to a certain extent. Holocain does not affect the circulation, and the escaping hemorrhage is many times favorable for such operations as the removal of foreign material from the eye, or the treatment of corneal ulcerations, inasmuch as the escaping hemorrhage will tend to free the part from contamination. This drug should never be injected hypodermically or given internally, as its extreme toxic properties contraindicate such a procedure. When a toxic dose is administered, it produces convulsions, and in many ways its symptoms are the same as those of cocain poisoning. In most instances the symptoms are not as alarming and severe as are those produced by cocain.

Magnesium Salts.—A saturated solution of magnesium sulphate possesses anesthetic properties. This compound has been injected to produce lumbar anesthesia by Meltzer, Guthrie, Ryan, Desguin, and others. Meltzer injected 1 mil of a 25 per cent sterile solution for each 12 kilograms of body weight, and he found within three hours the injection produced paralysis of the legs, thus permitting surgical operations to be performed upon the part which was supplied by the nerves which were blocked. The postoperative results are those of a prolongation of the paralysis and also retention of urine. Magnesium sulphate seems to have little or no effect upon the heart and the blood pressure, but in many cases it does have a marked influence on respiration.

Mylocal.—This is a local anesthetic solution which contains cocain or procain as the anesthetic, and in addition is antiseptic and is used as a local anesthetic in dentistry.

Novol.—Novol is a trade name given to procain, suprarenal extract tablets. Each tablet contains:

Procain	.02	grams
Suprarenal extract	.000045	"

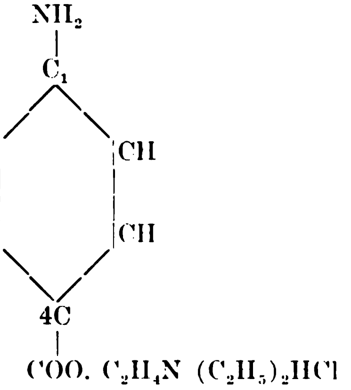
Neurocain.—This compound consists of small pellets which measure about 1 millimeter in thickness, and about 3 millimeters in length, and weigh 1/12 of a grain and are made from cocain hydrochlorid. These small pellets contain no foreign material whatsoever. Neurocain is, therefore, without excipient, and its composition being entirely of pure cocain hydrochlorid, it dissolves very easily when it comes in contact with water and has the advantage over the ordinary cocain crystals. Cocain in this form has been used considerably in pressure anesthesia for the removal of the dental pulp.

PROCAIN (NOVOCAIN).

Origin and Introduction.—Procain, which was formerly known as novocain, is a synthetic preparation, and was discovered by Einhorn in 1905. Procain is the term given to the compound which is made in America and is identical with novocain. This synthetic compound was formerly made in Germany, but under the provision of the Trading with the Enemy Act, the Federal Trade Commission took over the patent and issued licenses to American pharmaceutical concerns for its manufacture. The license issued to the American concerns makes it a condition that the product be called procain instead of novocain; also that the American-made product shall in every way be manufactured in the same manner and be identical with that formerly obtained from Germany. To insure the identity and chemical purity of this product, the Federal Trade Commission submitted the product, which was manufactured by the firms that were given the lawful right to produce it, to the American Medical Association Chemical Laboratory, in order to establish its chemical purity, and to the Cornell pharmacologist, H. A. Hatcher, with a view to determining its identity and toxicity. Therefore, the compound dispensed under the name of procain, which is made in America, is identical in every way with the substance first introduced under the term "novocain," and the term "procain" should be used in prescriptions and in scientific contributions.

The introduction of procain into the local anesthetic chain has contributed much to the advancement of local anesthesia, and it has proved to be a very valuable drug. Its discovery is the result of many efforts and endeavors on the part of numerous chemists who sought to discover an efficient synthetic local anesthetic which was endowed with anesthetic properties similar to those of cocain, and yet free from those undesirable qualities which result in so many cases in disaster while using the latter drug. Many substitutes have been offered to the profession for procain, and many of them have advantages over cocain in some form or another, but there is not one of these which has fulfilled all the requirements of an ideal local anesthetic. However, it seems that procain has come nearer giving us the desired results than any other local anesthetic heretofore presented.

Chemistry, Physical Properties, and Compounds.—Procain is a synthetic preparation which is chemically known as the monochlorhydrate of para-aminobenzoyldiethylaminoethanols which has the following graphic formula:



The chemical process required in the manufacture of procain is quite complex and difficult, and the author does not deem it necessary to go into that phase of the subject and give the various chemical steps in its preparation.

Many members of the profession are yet under the impression that procain is closely related to cocain, which is not the case. It is true that both procain and cocain produce local anesthesia, but these two compounds are entirely different, each one possessing an entirely different arrangement in the chemical make-up of the molecules. Cocain is an alkaloid obtained from the coca plant, while procain is a synthetic preparation made from chemicals Procain is a white crystalline powder and possesses the power of being heated to 120° C. without decomposing. It is neutral in reaction and is soluble in equal parts of water, and one to thirty parts alcohol. It melts at 156° C. Solutions made up from procain possess a slight antiseptic property, and such solutions can be boiled without decomposition, and last, but not least, solutions may be kept for several months without any apparent decomposition taking place, which is a factor not possessed by any other known anesthetic agent.

Caustic Alkalies.—Alkaline carbonates of the free base are precipitated from a solution containing procain as colorless, oily substances. Not only can a solution of procain be boiled a number of times without deterioration, but it can be kept in a proper flask for a number of days without decomposition or change in color. It is incompatible with alkaline carbonates, alkalies, iodids, and picric acid. The various compounds which we might mention here are *first,* procain base; *second,* procain hydrochlorid; *third,* procain nitrate.

Tests for Procain.—The same chemical tests are used to detect the presence of procain in a suspected solution as those used to detect cocain, which have already been given on page 225. But, the following test is made to distinguish procain from cocain: Place five mils (c.c.) of the suspected solution in a test tube, to which add five minims of dilute sulphuric acid, also five minims of potassium permanganate, and it will be found that the violet color disappears at once in case procain is present. Therefore it is an easy matter for the operator to make tests for the presence of cocain or novocain. The cocain and procain tests are valuable, but no doubt the above test will prove more valuable inasmuch as it differentiates cocain from procain.

Physiologic and Therapeutic Action.—Laboratory investigations show that procain, when injected in therapeutic doses either by the intravenous or subcutaneous route, has little effect upon the respiratory and circulatory systems. The author has had the pleasure of carrying out considerable research work not only upon dogs in the physiologic laboratory, but in a clinical way he has closely observed the effects of injecting this drug into numerous patients, having particularly noticed the blood pressure before and after injection, as well as the respiratory and circulatory systems. (See Chapter XVII.)

The injection of a procain solution produces no mydriasis, nor is the intraocular pressure increased, and accommodation is not disturbed. It does not produce as profound anesthesia as that of cocain, and the duration of anesthesia is shorter than cocain, if equal percentages of cocain and novocain are injected. The writer has injected a number of patients with a view of determining the relative intensity of anesthesia produced by these two drugs, and for this purpose he has injected the same patients. In other words, he has injected a cocain solution on one side, while on the other a procain solution, and the injections mostly used were the second division by the intraoral method, the inferior dental lingual nerve, and the anterior superior alveolar. For example, some patients were given a block injection on the left side, for the inferior dental lingual injection, which consisted of a one-half per cent cocain solution, while on the right side a one-half per cent solution of procain was injected, and the results of the two sides were compared. It was found that when both sides were blocked with the same percentages of procain and cocain, upon the side in which cocain was used a more profound and slightly longer anesthesia was obtained over that of the procain side. A large number of patients were injected in this manner, a similar technic was followed on both sides, the same quantity of solution used, and every precaution was taken to have the injections coincide as nearly as possible. The percentage of procain in the solution was gradually increased, and when two per cent was reached, practically all the patients injected said they could determine very little difference between the two sides of the face as to the intensity of the anesthesia and its duration. The conclusion reached following the injection of a large number of patients is that two per cent of procain solution produces as profound an anesthesia as that produced by one-half per cent solution of cocain, and its duration is similar. Procain is a local anesthetic which has the power to render the peripheral nerves or nerve trunks incapable of transmitting painful afferent impulses. Its action upon the terminal nerves is similar to that of cocain, and only varies in intensity and duration. When it is applied locally it is nonirritating, which is a quality that is most marked. When it is applied to even sensitive wounds and delicate tissues such as freshly incised wounds, in the form of a crystalline powder, or in a concentrated solution, it does not produce irritation.

One of the most useful and striking features of procain is that a solution of high percentage can be injected without pain to the patient, and it has no apparent action upon the tissues in the way of producing irritation, hyperemia, after-pain, inflammation, or other pathologic phenomena following its injection. It might be added that the injection of this drug has practically little or no influence upon the vasomotor nerves of the part injected, and last, but not least, one of the greatest advantages which it possesses is that it is not a habit-forming drug, and repeated injections of this compound can be made without any feeling of hesitancy on the part of the operator in starting the patient on the road to form the habit. *Repeated injections can be made without producing irritation, hyperemia, inflammation, or after-pain, or any untoward toxic symptoms, provided an isotonic Ringer vehicle is employed and the patient does not manifest any serious pathologic condition, and that an overamount has not been injected.*

The indications for using procain are the same as those for cocain, and the writer is of the opinion that procain can be used to better advantage than cocain. In fact, the indications for cocain today are so few that it could be entirely discarded, allowing not only procain but other cocain substitutes to be employed.

Local Use.—When procain solution is injected beneath the skin or mucous membrane, the patient may notice a very slight sensation of burning, which is due to the dilatation of the capillaries. This initial sensation of burning passes away in a few minutes, gradually being displaced by the sensation of anesthesia. The patient notices that the part seems swollen, because a slight hyperemia is produced, and also notices a slight burning sensation, which is caused by the solution being in contact with the peripheral nerve endings. The initial dilatation only occurs when a procain solution alone is injected, but when the solution contains a sufficient amount of epinephrin or synthetic suprarenin, this initial dilatation does not occur, but instead a vaso-constriction takes place. When the solution contains a proper amount of the vaso-constricting agent in conjunction with the anesthetic, many patients remark that the part seems swollen, on account of the presence of the solution and the action from the sensory nerves, and as soon as the solution attacks the delicate nerve endings or nerve trunks anesthesia begins at once. The epinephrin or synthetic combination not only prolongs the anesthesia but augments the action of the anesthetic.

Application to the Eye.—A solution of procain can be dropped into the eye upon the cornea and conjunctiva without irritating these delicate structures. Many ophthalmologists prefer cocain to procain in ophthalmologic practice; consequently cocain has remained the anesthetic of choice for this kind of work for many operators, due to the fact that procain is very slow in producing anesthesia of the cornea, and not only that, but many times it is impossible to anesthetize the deep tissues when it is applied topically. Procain has the advantage over cocain in that the former does not produce drying, neither does it have any deleterious effect upon the superficial corneal epithelium. On the other hand, cocain solution applied to the eye produces a transitory contraction of the pupil which is soon followed by dilatation. It also impairs accommodation, but it is not completely destroyed. The intraocular tension is lowered, and the pupil is dilated by the stimulation of the ends of the sympathetic nerves which innervate the iris. When cocain solution is applied to the eye it has a somewhat injurious action on the cornea in producing desquamation of the epithelium, and sometimes may produce keratitis. Procain solution does not produce a drying, nor does it have any effect upon the surface epithelium. When pure procain powder is dropped into the eye, only slight transitory changes are noted, which disappear in the course of a few hours, while if cocain powder is applied, the postoperative effects are more pronounced, and the changes in the tissue may be of a serious nature and may even terminate in keratitis. As previously stated, when cocain is carefully and judiciously applied in the practice of ophthalmology, it still seems to remain [illegible] of [illegible] for this particular field.

For Nose and Throat Surgery.—Procain for throat operations is rapidly taking a very [illegible] place in this specialty. The author employs it [illegible] solution, or in the pure powder, carry- [illegible] previously moistened with a solution [illegible] W[illegible] mucous membrane in the region of [illegible] pillars, soft palate, etc., ample time should be allowed to enable the anesthetic to become absorbed, and it must be borne in mind that it will not be absorbed, neither will anesthesia be produced as quickly as when a cocain solution is used. Procain, when used in this manner, acts more slowly than either cocain or alypin, and the anesthesia seems to be more transient.

With reference to the use of procain in nasal work, the writer has employed it for nasal and antral surgery, and the results obtained have been highly gratifying. Not only can the major part of the mucous membrane, the nasal septum, and other structures situated in the region of the nose be blocked by the deep nerve blocking injections, but these parts can be anesthetized by applying the procain solution directly to the mucous membrane with either a swab, which has been saturated in 20 per cent solution, or by applying procain crystals directly to the mucous part, the swab being previously moistened in a 1/3,000 solution of adrenalin or synthetic suprarenin. However, a better method, and one which is much easier for the operator is to saturate a piece of gauze or cotton of sufficient size with a 20 per cent solution of procain or the powder, and pack the tampon into the nasal cavity over the mucous membrane, or other parts to be operated. It is left in position for ten minutes which will, in most cases, produce profound anesthesia of the part. The tampon method can be used to very good advantage in connection with the deep nerve blocking method for nasal operations. Many operators have failed, inasmuch as they have not allowed ample time to elapse for the procain to produce a satisfactory anesthesia; in other words, they were too anxious to begin their operation and did not allow the anesthetic time to produce complete anesthesia. Ample time should be allowed for the solution to become absorbed, and it must be remembered that procain is somewhat slower in its action than cocain. The use of procain in nasal surgery should be encouraged from the fact that it is much less toxic than cocain, and it is in this particular field that many cases of collapse occur due to the rapid absorption of the drug by the mucous surface and the hypersensitiveness of the part.

For Deep Injections in Oral and Dental Surgery.—The injection of procain solution by the deep nerve blocking injection has already been discussed somewhat at length, but it might be well to state here that 2 per cent procain in combination with 1/250 to 1/500 per cent of the vaso-constricting agent, suprarenin, in the sterile physiologic, isotonic vehicle, known as Ringer's solution, makes an ideal combination for blocking deep nerve trunks, particularly in operations coming under the observation of the oral surgeon, eye, ear, nose, and throat specialist and dentist. This solution must be prepared accurately, and every precaution taken to have the solution conform to the many exacting laws which have been laid down by numerous investigators. The reader is referred to Chapters XIX and XX.

Local Anesthesia in Genitourinary Surgery.—The application of procain in genitourinary work has been very satisfactory, and instead of using the procain hydrochlorate, procain nitrate is employed in the urethral tract or in bladder surgery, or elsewhere, if silver nitrate or any silver compound is used, as the nitrate combination is compatible with silver. Procain nitrate is highly recommended in combination with the various silver salts for urethral injections. When this is used the pain which accompanies this procedure is eliminated, and anesthesia will be maintained for quite a while following the injection. Novocain nitrate is used in from one to four per cent solution, which is injected in combination with protargol, argyrol, etc.

Local Anesthesia in Abdominal Surgery.—In abdominal surgery local anesthesia is being employed quite extensively for appendectomy and herniotomy. Crile was one of the first advocates of this method in producing anoci-association. Many others, such as Leigh F. Watson, M. L. Harris, Matas, Allen, and Hetzler have added much to the literature in pointing out the value of local anesthesia in general surgery. The blocking of the afferent impulses is one link in the chain of anoci-association, which has proved to be of so much value in decreasing the mortality rate and in eliminating postoperative complications, such as distress, pain, etc. Crile recommends that the skin be infiltrated with a solution of procain in 1/400 solution in such a manner as to produce a broad white elevation in the skin in which the incision is made. Watson employs a stronger solution than Crile. Great care is taken not to extend the incision beyond the anesthetized zone. As the various tissues are entered, they are completely blocked by the anesthetic solution, and in case the operation is for a herniotomy, as soon as the skin and superficial fascia and external oblique muscles are separated, thus exposing the ilio-inguinal and ilio-hypogastric nerves, they are injected. If the technic is carried out in the right manner, the abdominal cavity is entered and no painful afferent impulses are generated and thus carried to the brain which cause pathologic changes in the brain cells.

Percentage of Procain Solutions Employed in Different Phases of Surgery.—The following percentages of procain solution are employed in certain forms of surgery:

1. For infiltration anesthesia, a solution of 0.25 grams (4 grains) procain in 100 or 50 grams (3.2 or 1.6 ounces) of Ringer's solution, with 5 or 10 minims of epinephrin solution (1:1000). A two per cent solution is sufficient in most cases for the infiltration method.

2. For instillations and injections, solutions of 0.1 gram (1½ grains) procain in 5 to 10 grams (75 to 150 grains) in Ringer's solution with or without 10 minims of epinephrin or synthetic suprarenin solution (1:1000).

3. In ophthalmology, a 5 to 10 per cent solution.

4. In rhinolaryngology, 5 to 20 per cent, with the addition of 6 to 8 minims of 1:1000 epinephrin or synthetic suprarenin solution to each 10 mils (150 minims), or the pure procain powder can be applied by an applicator which has been previously moistened in a solution of adrenalin.

5. For deep nerve blocking for oral or dental surgery, one half to 2 per cent solution ($\frac{1}{12}$ to $\frac{1}{3}$ grains procain) added to one mil of sterile Ringer's

solution containing sodium, calcium, potassium chlorids. Each mil should contain 1/3200 to 1/1600 grain of adrenalin or synthetic suprarenin.

Another way of preparing a solution for this particular branch of oral and dental surgery is to add one procain suprarenin Ringer tablet to one mil (c.c.) of sterile distilled water which makes a two per cent solution of procain, and a sufficient amount of the vaso-constricting agent, and at the same time a fresh Ringer solution. A two per cent solution is best adapted in block anesthesia for oral and dental operations.

6. Internally, owing to its feeble toxicity, it may be given in doses up to 0.5 grams (7½ grains) to adults.

7. For the injection of loose connective tissue and the capsule which surrounds tumors, a solution consisting of one-half per cent or even less can be employed. A one-quarter to one-half per cent is ideal for breast amputation. Endermic infiltration is easily accomplished by employing a one per cent solution. Infiltration anesthesia for thyroidectomy is from one-quarter to one-half per cent solution.

Note.—The reader is referred to Chapters XIX and XX for further information regarding solutions, etc.

Toxicity.—Most authorities claim that procain is from five to seven times less toxic than cocain, which means that from five to seven times more procain can be injected than cocain. On several occasions the writer has injected as much as eight grains of procain without producing any apparent ill-effects. This amount was given to three different patients for oral surgery operations. In one case the entire amount was injected within a period of ten minutes, while in each of the other two cases the various injections containing eight grains of procain were extended over a period of twenty minutes. In all three cases close observation was made of the circulation and respiration, and the sphygmomanometer was employed a number of times in order to keep a close watch on the blood pressure. The results in all three of these cases were highly gratifying. However, the writer does not wish to leave the impression that eight grains of procain can be injected into every patient. If an operator made this a routine procedure, he would undoubtedly find that not all individuals can by any means tolerate such an enormous amount of the drug. As previously stated, most operators claim that procain is from five to seven times less toxic than cocain, yet patients are met with who possess an idiosyncrasy for procain, and one should always inject any local anesthetic with caution. The author has observed that a smaller number of patients possess an idiosyncrasy for procain than for cocain, which speaks in favor of employing the former drug. He is aware of the fact that a large number of patients are hypersusceptible to even a small amount of cocain. Even if procain is a safer drug than cocain to inject, it is far better to see how little solution can be injected and produce the desired results than to inject a large quantity and bring about toxic symptoms.

While giving lectures and clinics at the Royal College of Dental Surgeons at Toronto, Canada, during a postgraduate course held in that institution. the writer had a very interesting and profitable experience, and a brief history of the case is as follows: The patient, aged 27, a soldier, who had just returned from the front, was among those to be operated at the clinic. He was in excellent physical condition, and the nature of the operation was the surgical removal of the upper central incisor. The first injections which were given by Dr. Charles Pearson, of Toronto, were infraorbital for the blocking of the anterior superior alveolar nerve, and in addition, a deep infiltration injection was made over the right central and lateral incisor teeth and over the left lateral and cuspid teeth. Following these injections, which amounted to 6 mils of a two per cent solution, it was impossible to make an incision of the mucous membrane. The patient was then referred to the writer, and a deep intraosseous injection was made above and between the apices of the upper left lateral and cuspid teeth. This solution was injected directly into the middle or cancellous plate of the alveolar process. Following this procedure several minutes were allowed to elapse, when a second attempt to operate was made. At this time it was only possible to make an incision through the mucous membrane and periosteum, which was not without pain by any means. The solution which had been injected thus far was out of the same receptacle which had been employed upon a number of other patients and with the production of profound anesthesia for the removal of several impacted teeth. The soldier was again subjected to a third attempt, and in order to produce anesthesia of the part, the writer this time made two deep intraosseous injections, one on the right side, located above and between the apices of the right central and lateral incisor teeth, and one on the left side being located between the apices of the lateral and cuspid teeth, and with each injection 2 mils of a four per cent solution were given. A fresh four per cent solution was made and a total of 4 mils was injected. After waiting ample time for anesthesia to take place, the operation was again attempted, and it was not possible to operate without inflicting excruciating pain. Dr. Le Roy Miner, of Harvard University, Boston, suggested that cocain crystals be employed. Cocain crystals were packed directly in contact with the part, but had no apparent effect. The total quantity of solution injected was 16 mils of a two per cent and 4 mils of a 4 per cent solution; in other words, a total amount of 8 grains of procain was injected, and in addition the cocain crystals, with no apparent results. The writer questioned this patient very carefully with much interest to himself and all members of the class, the patient stating that upon being injured in battle the physician gave him three injections of morphin, each containing one-quarter grain without effect; also, that they had considerable difficulty in anesthetizing him with chloroform. This was a very interesting case, and all those present profited by the demonstration. It was remarked that they obtained more information from witnessing such a case than from many others wherein perfect anesthesia was secured. It is very difficult to explain in a satisfactory way a case of this kind, and the only thing we can say is that the patient was suffering from shell shock, and the tissues would not succumb to the effect of the procain or cocain. Not only was he nonsusceptible to these local anesthetics, but also to morphin, and, to a certain extent, to chloroform. This is the third case in the author's experience which has proved unsatisfactory.

Liebel reports having injected six grains of procain into his own body, and after the effects of the anesthesia had passed off, he injected twelve grains in a ten per cent solution. Following the latter injection he manifested slight symptoms of intoxication, such as deafness, headache, and optic disturbances. These symptoms seemed to be of minor importance as they entirely disappeared in an hour and a half following the injection. The intoxication which is produced by the injection of an overamount of procain is very similar to those symptoms produced by cocain.

The addition of adrenalin or synthetic suprarenin to procain lowers the toxicity of this drug. It not only does this but it increases its intensity in producing anesthesia.

Several cases of collapse have been reported to the author by competent men who considered the collapse to be entirely due to the toxic action of procain. In addition, the writer has witnessed a few cases of collapse which he has attributed to the toxic action of the drug. In reporting such cases one should be very careful when making the assertion that collapse was due to the anesthetic drug injected, as it may not only be ascribed to this drug but may be due to the suprarenin or to a combination of factors, such as psychic fear, or to the operation itself. There is no question but that syncope, collapse or shock has been caused by the operation or by psychic depression when it was thought that the drug produced the condition. The operator should be positive as to the cause before making a positive assertion, and he should take all factors into consideration and weigh each cause separately and carefully.

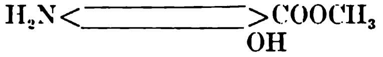
Treatment.—The treatment of collapse and shock, resulting from a toxic dose of procain, is similar to that of cocain poisoning, and the reader is referred to Chapter XXXVI entitled "Syncope, Collapse and Shock."

Novo Dentaesthin.—This anesthetic has been used in dental practice and contains

		Gm. or Mil	
℞	Beta eucain lactate		01
	Procain		015
	Suprarenin		00005
	Physiologic salt solution	1	

Obtundo.—This is a local dental anesthetic which contains cocain, chloreton, thymol, menthol, nitroglycerin, oil of wintergreen, oil of eucalyptus, and oil of cloves.

Orthoform (Old).—Orthoform (old) is a white crystalline powder which is almost insoluble. It possesses anesthetic properties when placed in contact with nerve tissue. On account of this drug being practically insoluble when placed in contact with wounds, it remains active for a long period. This compound also possesses antiseptic properties, and when both its antiseptic and anesthetic properties were considered, much enthusiasm was aroused over its possibilities, and it was immediately incorporated in ointments for treating ulcerated surfaces, burns, etc. It was used quite extensively until numerous reports were given of it. It had little effect except when placed directly in contact with nerve endings. It is not absorbed by the unbroken mucous membrane or skin. Orthoform (old) is known chemically as para-amido-meta-oxybenzoic acid methyl ester and has the following chemical formula:



$$H_2N<\underline{\qquad\qquad\qquad}>\underset{OH}{COOCH_3}$$

Orthoform (New).—Owing to the fact that much enthusiasm was displayed over orthoform (old), Einhorn did considerable experimental work along this line in 1897, and orthoform (new) was presented and is known chemically as methyl-meta-amino-para-oxybenzoate, which has the following formula:

$$C_6H_3\ NH_2\ OH.COO(CH_3),\ 3{:}4{:}1 = C_8H_9O_3N$$

which is the meta-amino-para-oxybenzoic acid ester of methyl alcohol.

The object of this new compound was to eliminate the toxic properties which were present with orthoform (old). However, this was not accomplished, as a number of toxic conditions have been reported; nevertheless the new orthoform is not nearly so toxic as orthoform (old).

Orthoform (new) has been used quite extensively in the past for a number of external and internal conditions, such as lesions about the larynx, throat, and nose, and wounds upon the external parts. Orthoform new is a fine, white, crystalline powder, neutral in action, having a melting point of 143° C. It is tasteless, odorless, and scarcely soluble in water, but is soluble in five times its volume of alcohol. When a solution containing it is boiled, it decomposes readily. It is a local anesthetic and closely resembles cocain in its local action. It does not penetrate the tissue, as cocain does, on account of its insolubility. When it is placed upon unbroken skin it is not absorbed and has practically no action except for a slight irritation. It is somewhat antiseptic, and can not be regarded as duly toxic when used in therapeutic doses. Many times it is used internally to relieve the pain of gastric ulcer, and, inasmuch as it acts only upon ulcerated surfaces, it is valuable in a suspected case of gastric ulcer, for pain is relieved. This is considered very good evidence that an ulcer exists. It has been used extensively as a local analgesic for wounds of almost every description, and also to great advantage for wounds about the jaws and neck, as well as dental operations, nasal catarrh, and hay fever. The fact that it does not penetrate mucous membrane and unbroken tissue shows that its action is limited, and it must be in contact with the nerve endings or nerve trunks in order to produce anesthesia. It is of value when pain is experienced by sprinkling the powder over the part either in a pure state or mixed with some bland agent, or it can be given in the form of an ointment or collodion.

The toxic symptoms usually manifest themselves first by a burning or smarting sensation, followed by pain at the site of application, which is also accompanied by an elevation of temperature, rapid pulse, and extreme prostration may be present in some cases. A peculiar odor is noticed, and severe itching may accompany the toxic symptoms. Orthoform (new) has almost been supplanted by anesthesin, which is far superior to the former.

QUININ AND UREA HYDROCHLORID

A number of years ago Griswold, of Fredonia, New York, recorded his investigations with quinin as a local anesthetic, but his announcement was either discarded or forgotten until Dr. Henry Thibault, of Scott, Arkansas, discovered its anesthetic properties in 1907.

Chemistry and Physical Properties.—Quinin and urea hydrochlorid is known chemically as carbamated quinin dihydrochlorid, and has a formula of

$$C_{20}H_{24}N_2O_2HCl + CH_4N_2O.\ HCl + 5H_2O$$

It is an interesting fact that all the soluble salts of quinin act as a local anesthetic when applied to nerve trunks or terminal nerves. Quinin and urea hydrochlorid is a salt which is composed of one molecule of quinin hydrochlorid, and one molecule of urea hydrochlorid. This compound occurs as white, interlaced prismatic crystals which are odorless, having a very bitter taste, and is soluble in equal parts of water. A concentrated solution of quinin and urea hydrochlorid is amber colored in appearance. Its salt is not hygroscopic, is unalterable and remains permanent in the air. Quinin and urea hydrochlorid can be boiled almost indefinitely without decomposition, but if they are left standing for a considerable length of time decomposition will take place.

Physiologic Action and Uses.—Quinin and urea hydrochlorid has exactly the same action as quinin and is nonirritating when injected hypodermatically. The discovery that quinin and urea hydrochlorid would produce anesthesia was a great step in advance for local anesthesia. It can be applied locally to the mucous membrane and it exerts an anesthetic action which is very similar to that of cocain in intensity, but the part remains anesthetic for a number of days following the injection.

Griswold reported before the Chautauqua County (New York) Medical Society that quinin could be used hypodermatically as an efficient local anesthetic. In the year 1907 Thibault, of Arkansas, found that quinin and urea hydrochlorid would produce deep and prolonged anesthesia which he discovered following his hypodermatic treatment for malaria. At the point of injection he noticed the parts would remain anesthetized for several days following the injection. After this discovery he began experimenting with the drug and soon learned that a one to three per cent solution would produce a deep anesthesia which would last for several hours and even days, and was far safer than cocain. The compound usually selected for a local anesthetic is quinin and urea hydrochlorid, inasmuch as it is soluble in equal parts of water. However, other soluble salts of quinin are equally as efficient, and even the insoluble salts of quinin, when slightly acidified, can be dissolved in sufficient quantity to produce anesthesia. This knowledge may be of value some time when other drugs for producing local anesthesia are not available. It is of interest to know that quinin and urea hydrochlorid not only produces anesthesia of the sensory nerve endings or nerve trunks, but when the solution is brought in contact with the blood it arrests the ameboid movement of the white cells, gradually becoming white in color and finally undergoing the process of crenation.

It has been found that quinin has a powerful influence over the protoplasm which makes up the cells, and when it is injected, a prolonged anesthesia of the parts remains for hours or even days, although it may cause some coagulation and damage of the tissue at the point of injection. Hertzler says: "When a soluble salt of quinin is injected into the tissue, it causes an exudate which is at first amorphous; if the solution remains confined in the tissues, it soon coagulates, forming granular fibers. The coagulation begins a few minutes after injection and is complete in from twelve to twenty-four hours." It is also noted that when the skin is infiltrated it becomes red in color and is somewhat thickened, and this at once suggests a leukocytosis and hyperemia; but, on the other hand, this part is not sensitive to the touch as would be the case if there was inflammation of the tissue. Fibrin is formed in the part which is granular in character, and is not changed or replaced by permanent fibrous tissue, but is absorbed within a few days following the injection, and the tissues soon resume their normal state. Hertzler also states that when quinin solution is injected into a nerve trunk, the action is similar to that which takes place when the solution is injected beneath the skin. This granular fibrin which is formed in contact with the nerve fibers themselves may compress and displace them, but do not change the nerve fibers themselves.

Many operators who have had experience with quinin and urea state that its injection produces edema, a statement which is incorrect, from the very fact that the substance formed is spontaneously coagulable, whereas if it was true edema the tissue at the point of injection would not be capable of taking immediate steps toward initial repair until the edema had subsided. Therefore, the exudate which is produced by the injection of the quinin and urea hydrochlorid is the first step toward speedy repair, and as Hertzler puts it, it is a misdirected one and may do harm, if improperly employed. If it is used with intelligence and all due care is taken during its administration, it is an efficient and valuable local anesthetic. It must be borne in mind that the infiltrated and reddened condition of the skin is not an inflammatory reaction, and the operator should not lose sight of the fact that when a quantity of the solution is injected beneath the skin or mucous membrane, and the tissue is incised a few minutes following the injection, that a considerable amount of the solution escapes with the hemorrhage and the formation of fibrous tissue, as already described, takes place to a very limited extent, and not only this, but the anesthesia remains only for a few hours following the injection. If prompt healing of the part is desired, it is well to inject as little of the solution as possible during the operation. On the other hand, if it is impossible to obtain primary union, it may be desirable to maintain prolonged anesthesia a number of days, and when such is the case the solution is injected into the tissue and allowed to remain. It is claimed that the exudate which forms as a result of the quinin and urea injection causes pressure upon the surrounding tissues which has a tendency to lessen the hemorrhage and exudate. If the solution is injected deeply into the tissue and allowed to remain, fibrous tissue forms and as a result of anesthesia will last from two to fifteen days. This is a very valuable property in favor of quinin and urea anesthesia for surgical operations upon the throat, jaws, anus and other locations, as it lessens or eliminates postoperative pain which follows these operations. When the operator is using quinin and urea hydrochlorid as a local anesthetic, he should by all means take into consideration the exudate which is formed and the prolonged anesthesia which is obtained, provided the solution is deeply injected and is allowed to remain in the tissues. Some operators prefer to add a small amount of adrenalin or synthetic suprarenin to the quinin and urea hydrochlorid, which prevents the vaso-dilation of the capillaries or arterioles at the time the quinin and urea is injected. The adrenalin produces immediate vaso-constriction of the part which seems to lessen the amount of exudate, and last, but not least, it shortens the duration of the anesthesia. When quinin and urea hydrochlorid is applied topically to the mucous membrane of the mouth, even in concentrated solution, it seems to have little anesthetic effect, which is no doubt due to the very slow absorption of the drug. An injection of quinin and urea hydrochlorid has little effect upon immediate hemorrhage, but as the anesthesia deepens it acts as a hemostatic, thereby checking the flow of blood to some extent. The urea hydrochlorid, which is in combination with quinin hydrochlorid, seems to have no effect whatsoever upon the tissues, and the object of its being combined with quinin hydrochlorid is to render the latter more soluble. Quinin hydrochlorid is soluble in one to thirty-four parts of water.

External Application of Quinin and Urea Hydrochlorid.—This compound, when applied externally, is very slow in its action as compared with procain and cocain. On account of its action being much slower than procain and cocain, the prolonged effect it produces places it far superior to cocain and procain in this particular respect. The topical application of quinin and urea hydrochlorid has not been used to any considerable extent, although the author has used it with satisfaction on several occasions for nasal and antrum operations by the tamponing method.

The author has in a number of cases injected quinin and urea hydrochlorid for blocking the nerve trunks for oral and dental surgery, and the results have been very satisfactory. One-half per cent solution was employed.

Tampon Method.—When it is used in the nasal cavity for nasal surgery, it can be applied upon a tampon, as already described under procain and cocain. As quinin and urea hydrochlorid are nontoxic, a large amount can be used. The tampon should be frequently changed and should be as large as possible to pack into the nasal cavity. The tampon should be changed at least four times, allowing it to remain in position from five to ten minutes. As soon as anesthesia has been produced, the mucous surface should be gone over with a tampon which has been saturated with a 1-1000 solution of adrenalin, which will cause ischemia of the part and prevent hemorrhage. Quinin and urea hydrochlorid by the injection method has become very popular with many general surgeons, and is being used very extensively by Hertzler and Crile and others.

The drug should be used with caution, even if it is nontoxic, for deep nerve blocking injections for oral and dental surgery, inasmuch as it produces an exudate and prolonged anesthesia and sloughing in some cases. The author has experienced very little difficulty following its administration, and in only a few cases encountered any sloughing of the tissues.

Percentages of Solution Employed.—One per cent quinin and urea hydrochlorid is sufficient to produce anesthesia for nearly all operations. Even a one-fourth or one-half per cent solution, skillfully injected, will produce very satisfactory results. If primary union is desired, and the operation is upon the face or is situated in loose connective tissue, or for plastic operations upon the head and neck, one-quarter to one-half per cent solution is more efficient. If prolonged anesthesia is necessary, as for an extensive operation, or for controlling postoperative pain resulting from a surgical operation, a one per cent solution should be employed. It is much better to prepare the solution just before it is injected, as it disintegrates if kept standing for several days. Some operators prefer a three or four per cent solution. Experience, however, has proved that one per cent solution is sufficient for such operations as come within the domain of the oral surgeon, eye, ear, nose and throat specialist, and dentist. If a deep injection has been made to anesthetize a nerve branch, twenty minutes' time should elapse from the time of injection until the operation is begun.

Toxicity of Quinin and Urea Hydrochlorid.—The compound seems to However, just because the drug is nontoxic, the operator should not take advantage of this fact and inject an enormous quantity which would produce have no toxic effect on a patient even when injected in a large quantity.

prolonged anesthesia and invite postoperative effects, such as sloughing. When Thibault discovered its anesthetic properties he certainly added a valuable link to the surgeon's resources of eliminating pain, and not only that, but it has added wonderfully to the technic of producing local anesthesia. Its nontoxicity and long duration of anesthesia will, at all times, keep this compound in the minds of every anesthetist and surgeon. Its drawbacks, which now confront us, may in time be eliminated or, at least, be reduced by combining this drug with other agents which may neutralize or, at least, modify its undesirable action, such as prolonged anesthesia and its tendency to produce sloughing.

Sal Anestheticum Schleichii.—This is a local anesthetic solution which contains various amounts of cocain hydrochlorid, morphin hydrochlorid and sodium chlorid, to produce anesthesia by infiltration, according to the method of Schleich. The three solutions which were originally used by Schleich for infiltration anesthesia consisted of three different degrees of strength, which were as follows:

1. Sal anestheticum Schleichii I (strong):

℞	Cocain hydrochlorid	0.2	(gr. 3)
	Morphin hydrochlorid	0.025	(gr. 1/3)
	Sodium chlorid	0.2	(gr. 3)

2. Sal anestheticum Schleichii II (normal):

℞	Cocain hydrochlorid	0.1	(gr. 1 2/3)
	Morphin hydrochlorid	0.025	(gr. 1/3)
	Sodium chlorid	0.2	(gr. 3)

3. Sal anestheticum Schleichii III (weak):

℞	Cocain hydrochlorid	0.01	(gr. 1/6)
	Morphin hydrochlorid	0.005	(gr. 1/12)
	Sodium chlorid	0.2	(gr. 3)

Schleich found he could use alypin to advantage when combining it with cocain, and consequently advised the substitution of the above solutions for the following:

		I	II	III
℞	Cocain hydrochlorid	0.1	0.05	0.01
	Alypin	0.1	0.05	0.01
	Sodium chlorid	0.2	0.2	0.2
	Distilled water	100.0	100.0	100.0

It will be noticed that the above formula does not contain the vaso-constricting agent adrenalin or synthetic suprarenin, inasmuch as Schleich feared unpleasant secondary symptoms following its administration.

Sinecain.—This is a compound which contains three per cent of quinin hydrochlorid, three per cent of antipyrin, and 0.05 mg. of adrenalin in water as the vehicle, and has been employed as a local anesthetic.

STOVAIN

This is a synthetic local anesthetic discovered by Fourneau, a French chemist. It is known chemically as benzoyl ethyl dimethylaminopropanol hydrochlorid, and has the following chemical formula:

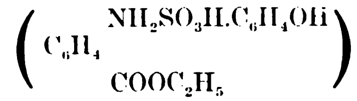
$$CH_3CH_2C(C_6H_5COO)(CH_3)CH_2N(CH_3)_2.HCl$$

Chemical and Physical Properties.—It is a synthetic compound and is closely related to alypin, and was first used in 1904 by Chaput in producing subarachnoid analgesia. It consists of small brilliant flakes or scales having a melting point of 175° C. Stovain is very soluble in water, and it makes up solutions which are stable and may be sterilized at 115° C. without fear of decomposition. Stovain is precipitated from solution by all the alkaloidal reagents and is broken down by very dilute alkali solutions. Therefore, it is incompatible with alkaloidal and alkali reagents. This synthetic anesthetic was introduced as an efficient substitute for cocain, but it has not proved to be as valuable as it was thought it would be at one time, due doubtless to its toxicity and to the fact that adrenalin can not be combined with it.

Action and Uses.—Stovain is a local anesthetic having about the same power as cocain, but it dilates the blood vessels, whereas cocain contracts them. It is considered to be one-third to one-half as toxic as cocain. Tuffier and Reclus have done some good work with it and recommended it for spinal anesthesia, and it has been used considerably for this purpose, but as it produces toxic symptoms in many cases and causes irritation of the nerve tissues, it is not being used as much at this time as it was in the past. Most authorities agree that it is less toxic than cocain, and that the duration of anesthesia does not last as long as that of cocain, and when toxic symptoms develop following its injection they are very similar to those following cocain. When solutions are injected into the tissue, the patient first experiences a slight burning pain, which is soon followed by deep anesthesia, and in some cases an area of inflammation is apparent at the site of injection, and in other cases the injection of a ten per cent solution has been followed by necrosis of the tissues. When a solution of stovain is instilled into the eye it causes a very marked burning sensation, extreme lacrimation and photophobia. The pupil becomes contracted, and the parts are extremely hyperemic. It is true that stovain possesses several properties which do not make it the ideal anesthetic by any means, but with its disadvantages it is superior to cocain. Its principal advantage is that two or three times as much of it can be injected. The safe dose of stovain is placed at 30 mils of a 1/200 solution, but even a greater amount than this has been injected without the development of postoperative complications. Stovain is employed more in spinal analgesia than in any other branch of local anesthesia and is being used at the present time by a number of surgeons. Its chief reason for being used is that it is less toxic than cocain, it can be boiled without decomposition, is mildly antiseptic, and is very soluble in water. It paralyzes all the sphincters, such as the vesical, uterine, and anal. It exerts far more effect on the motor nerves than cocain does. This being the case, it produces muscular relaxation when it is injected into the spinal canal and allowed to come in contact with the roots of the motor nerves. This one feature makes it a valuable agent to use when spinal anesthesia is indicated for abdominal operations, as it permits deep muscular relaxation which is advantageous to the surgeon. It is employed in five and ten per cent solutions for spinal anesthesia, and one-half to one per cent solution for hypodermatic injections for the production of local anesthesia.

Dosage.—Internally 0.002 gram (1/30 grain.) Locally, from five to ten per cent solution for application to the mucous membrane for nasal and throat operations. For hypodermatic injections for local anesthesia, in 0.75 to one per cent solution; in a 5 to 10 per cent solution for producing spinal anesthesia.

Subcutin.—Subcutin is a local anesthetic which was introduced by Ritsert, and is prepared by the action of paraphenol sulphuric acid upon anesthesin. It is said to be nontoxic and to possess germicidal properties. It has the following chemical formula:



$$\left(C_6H_4\begin{matrix} NH_2SO_3H.C_6H_4OH \\ \\ COOC_2H_5 \end{matrix}\right)$$

It appears in white, fine, crystalline powder, and has a melting point of 195.6° C. It is soluble to the extent of 2.5 parts in one hundred parts of warm water. It is not decomposed by boiling, and when injected it does not produce pain, and anesthesia follows at once. Some users of this drug have reported that following its injection the site of injection showed an inflammatory reaction. It does not produce as deep an anesthesia as cocain, and the anesthetic effect disappears much quicker than when cocain is employed. When it is placed in contact with the tongue it produces numbness. Anesthesin (see first part of this chapter) is a drug which is almost insoluble in water, and it is, therefore, not adapted for local anesthesia. This drawback caused Ritsert to do experimental work with anesthesin compound in order to prepare a compound which would possess a greater solubility, and yet be endowed with the anesthetic property, without producing irritation. His research work resulted in finding that phenol sulphonate or subcutin answered these requirements. The parasulphonate of anesthesin, which is known as subcutin, when injected hypodermatically, produces postoperative pain because the solution is acid in reaction.

Tropacocain.—This agent was first isolated from the coca plant by Giesel, and its action is similar to that of cocain, with the exception that it produces anesthesia much quicker than cocain, and retains the anesthetic effect about one-half as long. The toxic symptoms arising from the use of this drug are not so pronounced and are of a much shorter duration than those of cocain. When solutions of tropacocain are instilled into the eye, the drug produces profound anesthesia in about half the time required by solutions of cocain, with no ischemia; and accommodation is not impaired. This drug has not become very popular as a local anesthetic, but it has been used by some operators for spinal analgesia.

The compound employed is tropacocain hydrochlorid which has the following chemical formula:

$$C_8H_{14}\ NO(C_7H_5O)\ HCl$$

This drug is now prepared synthetically and is known as the hydrochlorid of synthetic tropacocain. It can be used instead of cocain hydrochlorid as it possesses several properties that the cocain solution does not possess. The solution is more stable, easily sterilizable, and has a less toxic action upon the heart. It can be used in ophthalmology, general surgery by the Schleich infiltration method, in dentistry, in regional anesthesia, and in lumbar or spinal anesthesia. Its toxic action is about one-half of that of cocain.

Dosage.—It is applied in from three to ten per cent aqueous solution, and contains 0.6 per cent sodium chlorid.

Water.—Water has been employed somewhat as a local anesthetic, not that it produces any local anesthetic action within itself, but the pressure it exerts causes pressure upon the terminal nerve endings, and produces anesthesia. It has been used in dentistry and in minor surgical cases.

Wilson's Local Anesthetic.—This is a solution of one per cent cocain, trinitrin, hydronaphthol, eucalyptol, monarda, baptisia, gaultheria, thymol, benzoic acid, and boric acid.

Waite's Local Anesthetic.—This is a local anesthetic solution which is used in oral and dental surgery and contains the following ingredients: cocain, phenol, glycerinum, iodum, thyme, eucalyptus, mentha-arvensis, baptisia, gaultheria, and benzo-boracic acid. Each 29.57 cubic centimeters contains 0.344 grams of cocain hydrochlorid.

CHAPTER XV

ANESTHETIC FORMULAS, TABLETS, AND SOLUTIONS

ANESTHETIC FORMULAS

The most important local anesthetics and their combinations will now be discussed. The reader should carefully note the amount of the anesthetic drug, the vaso-constricting agent, adrenalin or synthetic suprarenin, and the vehicle employed.

LOCAL ANESTHETIC TABLETS AND SOLUTIONS

Various local anesthetic tablets containing different amounts of the local anesthetic in combination with the vaso-constricting agent, as well as other constituents, are now offered to the profession. The tablet combination is a convenient form of making a fresh local anesthetic solution at the time of operation, which in many respects is superior to the stock solution. The writer has employed the tablet preparation method for a number of years and recommends its use over a stock solution. A fresh solution is very easily prepared by adding the proper tablet to a given amount of the vehicle, which gives a definite percentage of the anesthetic and the vaso-constricting agent. Some stock solutions should never be employed because they contain certain compounds which are irritating to the tissues; besides there is a great chance for disintegration and contamination. However, a stock local anesthetic solution, which is accurately compounded, composed of the proper ingredients, contained in alkaline free, amber-colored, sterile, sealed ampoules, has merit, but cannot be recommended over the preparation of a fresh solution from tablets as needed.

We will first consider the various combinations of cocain, inasmuch as it has occupied a prominent place in local anesthesia in the past. However, in this modern age, it does not occupy as prominent a position as it formerly did in the production of local anesthesia, on account of its extreme toxicity.

H.T. No. 151 (*P.D.*):

℞	Cocain hydrochlorid	gr. 1/6
	Adrenalin	gr. 1/300

Sig.: Add 1 tablet to the vehicle which will make a 1 per cent solution of cocain and 1 5000 solution of adrenalin.

H. T. "B" No. 178 (*P.D.*):

℞	Cocain hydrochlorid	gr.1/12
	Adrenalin	gr. 1/300

Sig.: One tablet added to 1 mil of vehicle makes ½ per cent of cocain and 1/5000 solution of adrenalin.

H. T. "D" No. 203 (*P.D.*):

℞	Cocain hydrochlorid	gr. 1/6
	Adrenalin	gr. 1/600

Sig.: One tablet added to 1 mil of vehicle makes a 1 per cent solution of cocain and adrenalin 1/10,000.

These tablets are of narrow cylinder shape and can be readily divided or inserted whole into the pulp chamber for pressure anesthesia.

H.T. No. 81 (*P.D.*). (*Suggested by Dr. N. S. Hoff, Ann Arbor, Mich.*):

℞	Cocain hydrochlorid	gr. 1/2
	Morphin sulphate	gr. 1/8
	Atropin sulphate	gr. 1/200

H.T. No. 200 *"B"* (*P.D.*). (*Suggested by Dr. N. S. Hoff, Ann Arbor, Mich.*):

℞	Cocain hydrochlorid	gr. 1/4
	Morphin sulphate	gr. 1/16
	Atropin sulphate	gr. 1/400

Local anesthetic solution suggested by Dr. Hermann Prinz:

℞	Cocain hydrochlorid	gr. v
	Sodium chlorid	gr. iv
	Distilled water	℥ i
	Misce.	

Sig.: Use as a local anesthetic. Add one minim of a 1/10,000 solution of epinephrin to each mil when used. This makes a 1 per cent solution of cocain.

Local obtundent suggested by Dr. Jenkins:

℞	Cocain hydrochlorid	gr. xv
	Liquid phenol	ʒ i
	Misce.	

Sig.: Heat the solution and apply to the sensitive dentin.

Formula of Dr. J. P. Buckley. (*Lilly*):

℞	Cocain hydrochlorid	gr. 1/12

This is in the form of freely soluble, miniature cylinders suitable for removal of the dental pulp by the pressure method.

Local anesthetic solution, formula of Dr. J. P. Buckley. (*Lilly*):

℞	Cocain hydrochlorid	gr. v

This amount of cocain is dissolved in one ounce of physiologic saline solution which contains a small amount of phenol and peppermint. Makes one per cent solution of cocain.

Anesthetic tablets. Formula of Dr. Schleich. These tablets are employed for infiltration anesthesia and are supplied in three different strengths. (Lilly):

℞	No. 1 Strong.	
	Cocain hydrochlorid	gr. 1/5
	Morphin hydrochlorid	gr. 1/40
	Sodium chlorid	gr. 1/5
℞	No. 2 Normal	
	Cocain hydrochlorid	gr. 1/10
	Morphin hydrochlorid	gr. 1/40
	Sodium chlorid	gr. 1/5
℞	No. 3 Weak	
	Cocain hydrochlorid	gr. 1/100
	Morphin hydrochlorid	gr. 1/40
	Sodium chlorid	gr. 1/5

To prepare solution for injection by infiltration method, select the proper tablet, either No. 1, No. 2, or No. 3, as indicated, and dissolve one tablet to each 100 minims (6.5 mils) of sterile distilled water.

NOTE: The sodium chlorid does not produce an isotonic, physiologic vehicle such as produced by Ringer constituents.

Anesthetic tablets. (*Lilly*):

℞	Cocain hydrochlorid	gr. 1/2
	Morphin sulphate	gr. 1/8
	Atropin sulphate	gr. 1/200

Sig.: Add one tablet to 25 minims of vehicle which makes a 2 per cent solution of cocain.

Local anesthetic tablet. (*Lilly*):

℞	Cocain hydrochlorid	gr. 1/8
	Morphin sulphate	gr. 1/32
	Atropin sulphate	gr. 1/800

Sig.: Add one tablet to 25 minims of the vehicle which makes a 1/2 per cent solution of cocain.

Local anesthetic solution:

		Gm. or Mil	
℞	Cocainæ hydrochloridi	16	(gr. iiss)
	Atropinæ sulphatis	008	(gr. 1/8)
	Strychninæ sulphatis	03	(gr. ss)
	Phenolis	12	(mm. ii)
	Aquæ dest.	15	(fld. ℥ ss)
Misce.			

The above solution contains 1 per cent of cocain. Each mil contains 1/6 gr. cocain (medium dosage) with 1/120 gr. of atropin, and 1/30 gr. of strychnine. Add 1 minim of a 1 1,000 solution of adrenalin to each mil.

The carbolic acid which is 0.8 per cent is for preservation. The atropin and strychnin are stimulants.

Braun's formulas. Local anesthetic solutions:

No. 1.

		Gm. or Mil	
℞	Cocain hydrochlorid		01
	Suprarenin (1% solution)		03
	Normal saline solution	100	

No. 2.

		Gm. or Mil	
℞	Cocain hydrochlorid		3
	Suprarenin (1% solution)		3
	Normal saline solution	50	

No. 3.

		Gm. or Mil	
℞	Cocain hydrochlorid		5
	Suprarenin (1% solution)		6
	Normal saline solution	10	

No. 4.

		Gm. or Mil	
℞	Cocain hydrochlorid		05
	Suprarenin (1% solution)		6
	Normal saline solution	5	

NOTE: Normal saline solution contains only sodium chlorid and is not a Ringer solution. Ringer solution contains sodium, calcium, and potassium chlorids.

PROCAIN COMBINATIONS, TABLETS, AND SOLUTIONS

H.T. No. 187 (*P.D.*):

℞	Procain	gr. 1/3
	Adrenalin	gr. 1/600

One tablet added to one mil of the vehicle makes a two per cent solution of procain and adrenalin 1/10,000.

H.T. "B" No. 188 (*P.D.*):

℞	Procain	gr. 1/6
	Adrenalin	gr. 1/400

One tablet added to one mil of Ringer vehicle makes a one per cent solution of procain and adrenalin 1/6,000.

H.T. "C" No. 202 (*P.D.*):

℞	Procain	gr. iv
	Adrenalin	gr. 1/200

One tablet dissolved in five mils of the vehicle makes a five per cent solution of procain and adrenalin 1/15,000.

Local anesthetic solution. (*P.D.*):

℞	Procain	gr. 9-1/5
	Adrenalin chlorid	gr. 1/50
	Chloretone	gr. 2-1/4
	Normal salt solution, q.s. ad.	℥ i

This solution contains two per cent procain and 1/20,000 solution of adrenalin and is supplied in one ounce glass-stoppered bottles.

For application to dental pulp suggested by Dr. Hermann Prinz:

℞	Camphor	ʒ iss
	Chloral hydrate	ʒ iii
	Procain	gr. xlv

Misc.

Sig.: Apply to aching pulp on saturated cotton.

Local obtundent: Author's formula. For application to tooth sockets and exposed bone to control postoperative pain and prevent infection:

℞	Anesthesin	gr. xxv
	Chloretone	gr. xxv
	Menthol	gr. v
	Oil of wintergreen	gr. v
	White vaseline q.s. ad	℥ i

Misce.

Sig.: Fill tooth socket or cavity with above mixture, applying it with syringe and long flexible tube.

This obtundent acts upon the denuded alveolus, bone, soft tissue and exposed terminal nerve endings. It will give almost immediate relief to pain and prevents postoperative pain, also aids in keeping parts aseptic.

Local anesthetic solution. Formula of Dr. Hermann Prinz:

℞	Procain	gr. x
	Sodium chlorid	gr. iv
	Distilled water	℥ i

Sig.: Sterilize by boiling. Add 1 minim of 1/1000 solution of adrenalin to each mil.

Local anesthetic solution. Formula of Fischer:

℞	Procain	gr. xxiii	(1.5 gm.)
	Sodium chlorid	gr. xiv	(0.92 gm.)
	Thymol	gr. 1/3	(0.02 gm.)
	Distilled water	℥ iii	(90 mils)

NOTE: When ready for use, add 1 minim of 1/1,000 solution suprarenal extract. Sterilize by boiling before adding suprarenin content, and after it has been added, then bring to boiling point. The thymol is a preservative This solution contains 1½ per cent solution of procain.

Procain-Suprarenin-Ringer tablet. Author's formula:[*]

℞	Procain	0.02000
	Suprarenin synthetic	0.00004
	Sodium chlorid	0.00500
	Calcium chlorid	0.00040
	Potassium chlorid	0.00020

Add 1 tablet to 1 mil distilled sterile water which makes a 2 per cent procain 1/25,000 solution suprarenin, and a fresh Ringer isotonic vehicle, all at the same time. The procain which is ⅓ grain (0.02 gm.) makes a 2 per cent solution of the anesthetic which is used for oral surgery and dental operations. The amount of vaso-constricting agent, suprarenin, is 1/1,600 of a grain (0.00004 gm.). This amount will maintain profound anesthesia of the part for approximately 45 minutes. Combining the Ringer constituents in the same tablet with procain and suprarenin renders a fresh isotonic, physiologic Ringer vehicle when the tablets are added to distilled sterile water.

The following formula of the combination tablet contains a less amount of suprarenin than the formula above given and can be used where a short anesthesia and little anemia is desired, also in advanced pathologic cases.

℞	Procain	0.02000
	Suprarenin synthetic	0.00002
	Sodium chlorid	0.00500
	Calcium chlorid	0.00040
	Potassium chlorid	0.00020

Add 1 tablet to 1 mil of sterile distilled water, which makes a 2 per cent solution of procain, 1/50,000 solution suprarenin and a fresh Ringer isotonic vehicle, all at the same time.

℞	Procain	gr. 1/3 (0.02 gram)

Add 1 tablet per each mil distilled sterile water which makes a 2 per cent solution of procain. Add 1/1,000 solution suprarenal extract in amount necessary; usually from one to five minims per mil, depending upon location and nature of operation.

Tablet "D":

℞	Procain	gr. iii (0.2 gram)

One tablet added to 10 mils of vehicle makes a two per cent solution of procain. Add 1/1,000 suprarenal extract solution to above as desired, usually 1 minim per mil, depending upon location and extent of operation.

Tablet "F":

℞	Procain	gr. 5/6 (0.05 gram)

One tablet added per each mil of sterile distilled water makes approximately 5 per cent solution of procain.

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[*] In the development of this formula the author desires to acknowledge valuable assistance from the following: Professor W. D. Zoethout, Professor C. A. Cary, Dr. J. A. Corbett, Dr. George W. Funck, Dr. L. C. Emenhiser, and M. M. Burdick.

Tablet "A":

℞	Procain	gr. ii (0.125 gram)
	L-Suprarenin synthetic	gr. 1/500 (0.000125 gram)

One tablet dissolved in 1 mil of Ringer vehicle makes a 12 per cent solution of procain and 1/6000 solution suprarenin.

One tablet added to 25 mils of isotonic Ringer vehicle makes a ½ per cent solution of procain.

One tablet added to 10 mils of isotonic Ringer vehicle makes a 1¼ per cent solution of procain.

One tablet added to 25 mils of isotonic Ringer vehicle makes a 2½ per cent solution of procain.

Tablet "B":

℞	Procain	gr. iss (0.1 gram)
	L-Suprarenin synthetic	gr. 1/250 (0.00025 gram)

One tablet added to 10 mils isotonic Ringer vehicle makes a one per cent solution.

Tablet "C":

℞	Procain	gr. 5/6 (0.05 gram)
	L-Suprarenin synthetic	gr. 1/780 (0.000083 gram)

One tablet added to 1 mil of the Ringer vehicle makes approximately 5 per cent solution procain and 1/12,000 suprarenin solution.

Tablet "E":

℞	Procain	gr. 1/3 (0.02 gram)
	L-Suprarenin synthetic	gr. 1/1200 (0.00005 gram)

One tablet added to 1 mil of the isotonic Ringer vehicle makes a 2 per cent solution procain, and 1/20,000 solution suprarenin. One tablet added to 2 mils of the isotonic vehicle makes a 1 per cent solution of procain and 1/40,000 solution of suprarenin.

Tablet "F":

℞	Procain	gr. 5/6 (0.05 gram)

One tablet added to 1 mil isotonic vehicle makes a 5 per cent solution of procain. One tablet added to 2½ mils isotonic Ringer vehicle, makes a 2 per cent procain solution.

Add one tablet "F" and one tablet "E" to 3½ mils of the Ringer vehicle, which makes a 2 per cent solution of procain and 1/100,000 solution suprarenal extract.

Tablet "G":

℞	Procain	0.15 gram
	L-Suprarenin synthetic	0.00005 gram

One tablet added to 1 mil of the isotonic Ringer vehicle gives 1½ per cent solution of procain and 1/20,000 solution of the suprarenal extract.

Tablet "S":

℞	Procain	0.06 gram
	Sodium chlorid	0.022 gram

One tablet added to 3 mils of sterile distilled water makes a 2 per cent solution of procain and a normal saline solution.

Tablet "T":

℞	Procain	0.02 gram
	L-Suprarenin synthetic	0.00002 gram

One tablet added to 1 minim Ringer vehicle makes a 2 per cent solution of procain and 1/50,000 solution of suprarenin.

"Pluglets"

℞	Procain	0.01 gram
	Suprarenin synthetic	0.00002 gram

To be used for pressure anesthesia in removal of dental pulp.

APOTHESIN TABLETS AND SOLUTIONS

H.T. No. 216 (*P.D.*):

℞	Apothesin	1 1/4 grains (0.08 gm.)

To make up solution containing the percentage of apothesin indicated below, dissolve tablet No. 216 in the quantity of Ringer solution specified.

Strength of solution.	Quantity of solvent.
0.25%	1 fluid ounce
0.5 %	1/2 fluid ounce
1%	2 fluid drams
2%	1 fluid dram

H.T. No. 217 (*P.D.*):

℞	Apothesin	3/5 gr. (.039 gm.)
	Adrenalin	1/1600 gr. (.00004 gm.)

To make up a solution containing the percentage strengths of apothesin indicated below, dissolve tablet No. 217 in the quantity of Ringer solution specified.

Strength of solution	Quantity of Solvent
0.25%	1/2 fluid ounce
0.5 %	2 fluid drams
1%	1 fluid dram
2%	30 minims

H.T. No. 218 (*P.D.*):

℞	Apothesin	1/3 gr. (.02 gm.)
	Adrenalin	1/2500 gr. (.000025 gm.)

One tablet dissolved in 1 mil of vehicle makes a 2 per cent solution of apothesin, and adrenalin 1/40,000 solution. One tablet in 2 mils makes a 1 per cent solution apothesin and adrenalin 1/80,000.

QUININ AND UREA TABLETS AND SOLUTION

Quinin and urea hydrochlorid can be secured in tablet form containing ½, ⁷⁄₁₀, 2, 3, 4, and 5 grains. In addition to the quinin and urea tablet, a small amount of 1/1,000 solution of adrenalin can be added to the Ringer vehicle. Hertzler states that better results can be obtained when quinin and urea, procain and epinephrin are combined. He says "the quick action of procain, the vessel constricting action of epinephrin with the prolonged action of quinin, is obtained in the part and the result of the combination is that the full effect of neither is obtained. The constricting action of the epinephrin is compromised by the quinin and the prolonged effect of the quinin is lessened by the epinephrin." This being the case, there is no question but that this combination is valuable in certain operations where a relatively bloodless field is desired and to control after pain. Hertzler also states, "Anesthesia is easier to attain by this combination by virtue of the procain, the adrenalin secures a measure of anemia, and the quinin controls the after pain longer than where this drug is not employed." His formula is as follows:

℞	Procain	gr. v
	Quinin-urea-hydrochlorid	gr. ii
	Epinephrin (1/1000)	m. viii
	Distilled water	℥ i

Sig.: Sterilize by bringing to boiling point.

The author has employed the above solution with gratifying results in a number of deep nerve block injections for tonsillectomy and third molar impactions. However, instead of employing distilled water only as the vehicle, a Ringer solution was employed.

Ampoules. (Lilly.)

Ampoules of quinin and urea hydrochlorid can be obtained in various amounts and percentages as follows:

Quinin-urea hydrochlorid	1/4 of 1% in 1 mil ampoules
	1/2 of " " 1 " "
	1/2 of " " 20 " "
	1% in 1 " "
	1% in 5 " "

Quinin-urea hydrochlorid in ¼ to 1 per cent solutions is being used by a number of physicians and dentists as a local anesthetic. Its advantages are that it is practically nontoxic and furnishes an anesthesia lasting from 3 to 48 hours or longer, and in many cases it prevents the postoperative pain. Owing to its constricting and prolonged effect, it should be employed with caution in tissue where the circulation is below normal.

EUCAIN TABLETS AND SOLUTIONS

H.T. "B" No. 194 (*P.D.*):

℞	Eucain hydrochlorid "B"	gr. 1/7
	Adrenalin	gr. 1/400

One tablet added to 1 mil of vehicle makes approximately 1 per cent solution of eucain and adrenalin 1/1600.

Braun's formula:

℞	Eucain (Beta)	0.2
	Sodium chlorid	0.8
	Distilled water	100.0

This solution was very popular at one time. The adrenalin solution is added at the time of injection.

℞	Eucain (Beta)	0.0025 gram
	Adrenalin (1/1000 solution)	0.0001 "
	Ringer solution	1. "

Supplied in ampoules.

CHAPTER XVI

THE ACTIVE PRINCIPLE OF THE ADRENAL GLAND AND ITS SYNTHETIC SUBSTITUTES

The following subjects will be discussed in their order:

1. Anatomy of the suprarenal gland.
2. Active principle of the suprarenal gland.
3. Synthetic suprarenin.
4. Physiologic action and uses.
5. Its use in combating shock and collapse.
6. Uses of suprarenal extract in block anesthesia.
7. Suprarenal extract in combination with a local anesthetic.
8. Toxicity.
9. Dosage and mode of application.
10. Solution prepared from tablets.
11. Author's method.
12. Its value summarized.

ANATOMY OF THE SUPRARENAL GLAND

The adrenal or suprarenal glands belong to the chain of ductless glands, their function having to do with internal secretion. The suprarenal glands are not endowed with ducts, therefore they discharge the products of their activity, which is an internal secretion, directly into the blood stream, thereby exerting an influence upon the circulatory apparatus. The adrenal gland is composed of a cortical substance which forms the capsule and surrounds the medulla of chromophil tissue.

There are two suprarenal glands, the left and right, which are located in the epigastric region, one on either side of the spinal column. They occupy a very intimate relation to the superomedial part of the kidneys. They are yellowish-brown in color, having an average size of five centimeters in length, three centimeters in width, and one centimeter in thickness. The average weight is seven grams each. It is quite true the adrenal bodies are small, yet they are essential to life, for when they are removed, great muscular weakness and prostration, followed by a rapid fall in blood pressure, soon occurs, to be followed by death in a few hours.

The great sympathetic chain, situated in the thorax, gives off the great splanchnic nerve which has a very intimate association with the suprarenal gland, and in view of this intimate association it is believed the suprarenal gland is associated with the function of the sympathetic nervous system. As previously pointed out, the suprarenal gland is positively necessary to sustain life, and its importance to life is strikingly demonstrated when a solution containing an extract of the gland is injected into the circulation which causes an immediate rise in blood pressure.

ACTIVE PRINCIPLE OF THE SUPRARENAL GLAND

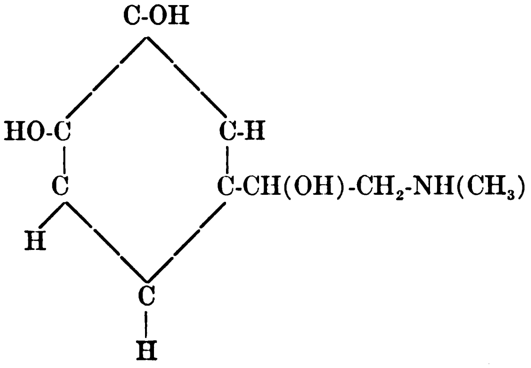
Chemistry and History of Isolation.—The active principle of the suprarenal gland has been given various names by the different pharmaceutical concerns, such as epinephrin, adrenin, adrenalin, suprarenin, suprarenalin, supracapsulin, adrin, adnephrin, epinin, paranephrin, hemostasin, epirenan, and hemisin. The term epinephrin was first suggested by the Council on Pharmacy and Chemistry of the American Medical Association to indicate the active principle of the suprarenal medulla. In consequence, the *Journal of the American Medical Association* now uses the word *epinephrin* exclusively and reports the work done with adrenalin, etc., with the standard word "epinephrin." Adrenin refers to the isolated active principle of the suprarenal gland and is identical with adrenalin. The former is the name given to the adrenal extract, generally adopted in British and French scientific literature, and does not include any special make.

Adrenalin, on the other hand, is a proprietary name which is applied to the isolated active principle of suprarenal medulla, and is compounded by an American pharmaceutical concern.

The organic active principle of the suprarenal is formed by the medullary cells having been isolated by different observers and given different names, such as epinephrin, adrenalin, and suprarenin, etc., as previously stated.

The credit for the isolation of the active principle belongs to Abel, Takamine, Fuerth and Aldrich. The preparation isolated by Fuerth was called suprarenin; the same product, isolated by Abel, was called epinephrin. Takamine and Aldrich, working independently of each other in the year 1901, were successful in isolating the active principle of the gland, and both gave it the name of adrenalin.

The structural arrangement of adrenalin is the levo-rotatory isomer of the formula:



This compound is known chemically as dioxyphenyl-ethanol-methylamin. It is used in the form of a soluble salt, such as the borate, bitartrate or hydrochlorid. The adrenalin base is only slightly soluble in cold water, but is more soluble in warm water; therefore it is used mostly in the form of a salt to increase its solubility. For example, a solution of adrenalin, in the form of a borate, will render a considerable quantity of the adrenalin solution soluble; also lessen the precipitation of such solutions by alkalies. Epinephrin or adrenalin is a powder which has a gray white appearance, possessing a slightly alkaline reaction in its dry form. When added to acid, it forms salts of that acid which are soluble. The suprarenal gland of the sheep is used principally for the isolation of the active principle, adrenalin. Adrenalin occurs in white crystalline form having a slightly bitter taste.

The solution employed for therapeutic purposes, as a rule, has the strength of 1/1,000 in a saline solution, to which preservatives are added, such as chlorotone, etc. This compound is very susceptible to any form of alkali, hence great care should be taken not to allow contamination, which will prove destructive to it. The solution should not be kept in an ordinary glass vial, which contains a free alkali, for fear of disintegration, but bottles of amber colored, alkaline-free glass should be employed.

Another way of retaining this solution is to use the ordinary glass container, after it has been treated with a dilute solution of hydrochloric acid, for, at least, three days, then thoroughly rinsed in distilled water. Solutions of adrenalin are not very stable when they are exposed to air or light.

There has been considerable controversy about adrenalin and its solutions since the advent of the synthetic suprarenin, and the author has pointed out time and again that an adrenalin solution assumes a slight amber color soon after it is prepared, and on standing, assumes a darker color. The writer will quote verbatim the words of the American compounders as follows: "Adrenalin solution, as oxidation progresses, turns pink, gradually becoming a deep red, then brown, at which time a precipitate forms and the therapeutic properties of the solution are lost, but it might be well to emphasize the point that the solution need not be discarded until it has turned a dark red and is beginning to precipitate, up to which time it retains the major part of its original medicinal activity."

The author has made many injections of the solution of amber color, and anesthesia has been secured with no more toxic symptoms than when synthetic suprarenin was employed. Synthetic suprarenin solution, when freshly made, is colorless and upon standing assumes a pinkish discoloration.

SYNTHETIC SUPRARENIN

Within recent years the active principle of the adrenal gland has been prepared synthetically, having physiologic properties similar to the product isolated directly from the gland. This substance in basic form is insoluble, which renders it impractical for therapeutic purposes; therefore, it is prepared in the form of a salt.

For the first preparation of synthetic suprarenin the credit belongs to Stoltz. Within recent years it has been carefully tested, both clinically and physiologically, and the concensus of opinion is that the synthetic product is equal to the organic preparation. When the discovery of the chemical arrangement of the organic preparation was made, it was not many years until the chemists were preparing the compound synthetically. Both synthetic suprarenin and the organic product adrenalin can be sterilized by boiling. Some observers claim that synthetic suprarenin can be boiled for a longer period of time than adrenalin without deterioration, but the writer questions this. Both adrenalin and the synthetic product can be boiled for sterilization at the time the solution is made for injection without deterioration. However, it is well not to subject the solution to prolonged boiling, whether it contains synthetic suprarenin or the organic adrenalin. The author advises the operator to bring the solution to the boiling point only after the anesthetic tablets have been added to the vehicle at the time it is being prepared for injection. It makes no difference so far as sterilization is concerned whether the tablets contain adrenalin or synthetic suprarenin. A tube of tablets should be sterile at the time of opening, and unless they are contaminated, there is no reason why the solution should be subjected to boiling for several minutes. But as previously stated, if the solution is brought to the boiling point after the tablets have been added to the vehicle, it is sufficient to eliminate any possible chance of causing a disintegration of the vaso-constricting agent. (See Chapter XX for Detailed Technic of Preparing Injecting Solution.)

Synthetic suprarenin has the same structural formula as that of adrenalin; it is a grey white powder, practically insoluble in cold water, but slightly soluble in hot water, and is also insoluble in alcohol or ether. It has a melting point of 207° C. The suprarenin base is not used, because of its insolubility, but some salt of the compound is employed instead.

The hydrochloric acid salt of suprarenin is unstable; therefore the bitartrate compound is the one mostly used on account of its greater stability and solubility.

Adrenalin is used far more extensively by the medical profession than the synthetic preparation; while, with the dental profession, it seems the synthetic preparation is used far more. Both synthetic suprarenin and adrenalin compounds are very sensitive to change, and the tablets or solutions containing either of these drugs should be protected from contamination, such as alkalies, light, heat, moisture, and air. Adrenalin chlorid is obtained commercially in the form of a tablet or solution. The solution contains one part of 1/1,000 adrenalin chlorid, held in suspension in a normal salt solution, to which has been added chloretone, which acts as a preservative. It is dispensed in small amber colored alkaline-free bottles and should be carefully protected from air, light, alkalies, etc., which will cause the color to change and deterioration to take place. If a solution is employed, the bottle should be immediately corked, never returning any unused portion. The bottle containing the solution should be kept in a cool, dark place, which also applies to the tablets containing either the adrenalin or synthetic suprarenin product. Change of color, as has already been stated, is the index to its deterioration. Upon its exposure to air, light, etc., the solution first assumes an amber or pink, then red, and finally brown color, and its medicinal activity varies in accordance with its color.

The writer has made experiments in the physiologic laboratory upon animals, injecting solutions ranging from a colorless one to a deep brown, and he finds that a freshly prepared solution is endowed with a greater vaso-constricting power than a solution which has been exposed to the atmosphere for a considerable length of time. The solution which has assumed a red or brown color shows no toxic symptoms up to the time of precipitation, but has lost the greater part of its vaso-constricting action. Bearing these facts in mind, it can be said that when the solution is of a slightly amber color, and is prepared from the organic adrenalin, it does not alter its therapeutic efficiency or its power to produce toxic symptoms. It has been the experience of numerous operators, also the writer's experience, in making deep nerve blocking injections, employing the solution when it is slightly amber-colored, that no more toxic symptoms have been noted than when the solution is perfectly colorless. However, when the solution has turned a dark red or brown with the formation of a precipitate, it should be discarded, in view of the fact that a certain percentage of the vaso-constricting agent has disintegrated and is inert. Therefore, the proper amount of vaso-constriction would not be obtained in order to maintain a prolonged anesthesia. The author does not agree with some writers on this subject who state that an amber-colored adrenalin solution is highly toxic, because experience in thousands of injections and researches in the laboratory on animals has proved this to be untrue. The slightly amber-colored solution made from the organic suprarenal extract does not indicate toxicity, but it does indicate a slight oxidation and deterioration. The original amount of the adrenalin is slightly lessened. Such a solution contains practically all of its original medicinal activities and when clinical experience and laboratory findings have established such facts, it should be conclusive evidence that the toxic properties of such a solution have been overrated.

The discovery and preparation of synthetic suprarenin have added another link to the chain of efficiency, and careful clinical tests which have been made show the value of this preparation, which is being used considerably at the present time. It is a white, crystalline powder in the form of a borate or bitartrate and is readily soluble in water. Many observers of this drug state its action is equal, and in some respects superior, to the organic preparation. The synthetic preparation is made from chemicals, and the claims which have been made in its favor are that it can be boiled for the purpose of sterilization, and that it can be secured in pure form. An adrenalin solution can be brought to the boiling point and sterilized in the same manner as if it contained the synthetic suprarenin preparation. It has been the writer's experience to observe practically no difference in the stability of the synthetic preparation and the organic adrenalin preparation, inasmuch as when the two solutions of the same strength are made and left exposed to the atmosphere they both will gradually undergo deterioration and change in color. A solution which has been prepared by adding the anesthetic tablets to the Ringer vehicle and left exposed will assume a pinkish discoloration. *Braun says: "Diluted solutions of suprarenin become red quickly when exposed to the air without, however, losing any of their effectiveness, and after longer exposure the solutions turn brown and are then unfit for use."*

The author has injected considerable quantities of the solution containing synthetic suprarenin for deep block anesthesia, even when the solution had assumed a slight pinkish color, without causing any untoward effects. However the solution should be discarded when it has assumed a pinkish color. Synthetic suprarenin is dispensed in the form of a tablet and 1/1,000 solution. The stock solution contains hydrochloric acid, acetone, thymol, or chloroform to render it stable.

PHYSIOLOGIC ACTION AND USES

Suprarenin is a powerful vaso-constricting agent, and in a very dilute solution will produce a local ischemia. This local ischemic condition takes the place of physical aids to control hemorrhage, such as cold and pressure. The vaso-constriction lessens the blood in the part, therefore retarding absorption and lessening or preventing hemorrhage. There is no question but that adrenalin or synthetic suprarenin is the most rapid and powerful hemostatic and astringent known. It produces pronounced local anemia of the part injected by reducing the size of the arterioles, thus increasing blood pressure. Its action is instantaneous when injected into the circulation, whereas if it is injected into the mucous membrane or into the skin, its action is much slower, due to its powerful vaso-constricting action, which lessens absorption, thus allowing only a small quantity to slowly enter the circulation.

It was first proved by Langley that epinephrin solution stimulates only involuntary muscle located in the blood vessels. Muscle of this type is innervated by sympathetic autonomic nerve fibers and the stimulating effect of epinephrin is not only exerted upon the smooth muscle itself, but it also has an effect upon the nerve fibers and upon the receptive substance which is located at the junction of the terminal fibers and the muscle. It would therefore seem that epinephrin has a selective action upon the terminal nerve endings of the sympathetic autonomic fibers as well as the smooth or involuntary muscle tissue.

The most striking evidence of the vaso-constricting action of this drug is made manifest when it is injected directly into the circulation. Such a procedure is quickly followed by an immediate rise in blood pressure. This rise in blood pressure is in proportion to the strength and amount of solution injected. An injection into the blood stream is immediately followed by a slowing of the heart, which is caused by the increased blood pressure and the stimulation of the vagus center. The heart is slowed secondarily or, in other words, the vaso-constriction produces a rise in blood pressure which excites and stimulates the vagus center which in turn slows the heart. The action of this agent is so great, when a solution is injected in the region of small arteries, say two millimeters in diameter, that it will cause a complete obliteration of the lumen, so an operation can be performed in the region with little or no hemorrhage. This pronounced action, however, will not remain any length of time, but will gradually wear away and hemorrhage will take place. It may be applied directly to the part in 1/1,000 strength, or injected into the tissues.

Dilute solutions which act as stimulants, are used in the treatment of collapse and shock (see Chapter XXXVI on Syncope, Shock and Collapse), in order to increase blood pressure. Only a small amount is necessary in connection with a local anesthetic to prevent rapid absorption of the anesthetic drug. This drug delays absorption on account of its vaso-constricting power, thus preventing rapid entrance of the anesthetic drug into the circulation, and in addition, it prolongs the anesthesia and augments the action of the anesthetic. It is of interest to know that suprarenin produces a greater vaso-constriction in some parts of the body than in others. For example, suprarenin has no effect whatsoever upon the blood vessels of the lung, it has a moderate action upon the bladder, a marked action upon the stomach and intestines, and upon the skin its action is very great.

The discovery of the suprarenal extract marked a great advance in local anesthesia, and had it not been for its discovery, local anesthesia would not be occupying the prominent position that it does today.

THE USE OF SUPRARENIN IN COMBATING SHOCK AND COLLAPSE

This drug is of great value when properly administered in the treatment of shock and collapse. It should be given in a weak continuous solution. When it is administered in this manner, a small amount enters the blood stream, thereby exerting its constricting action upon the muscles and nerve endings of the arterioles, thus stimulating the heart by increasing blood pressure. When it is given hypodermatically in case of collapse, it is of less value for the reason that its action is temporary. (See Chapter XXXVI on "Syncope, Shock and Collapse.")

USES OF SUPRARENAL EXTRACT IN BLOCK ANESTHESIA

Since the isolation of the suprarenal extract and its action became known, it has caused a very rapid development of block anesthesia. Its addition to the injecting solution has placed the various branches of local anesthesia upon the high plane which they occupy today, and were it not for this drug it would not be possible to obtain the results we are securing in block and infiltration anesthesia.

Suprarenal extract within itself is not a local anesthetic, but when it is combined with local anesthetics, such as procain, apothesin, etc., it augments their effects, prevents their rapid absorption and permits a larger amount of the anesthetic to be injected.

The names of numerous investigators are given in the literature, and they deserve much credit for the wonderful work they have accomplished along this line. Among these experimenters are Takamine, Abel, Teters, Moller, Carpenter, Heinze, Braun, and Lawen.

In 1902 Braun published the results of his many researches which have proved of immense value to the profession. Lawen, Heinze, and Braun have probably done more work than others along the line of working out fundamentals, which have proved of immense value with the synthetic drug and its uses in local anesthesia. This drug has not only played an important role in the production and maintenance of anesthesia for operations performed by the oral surgeon and dentist, but another important factor is that it prevents or lessens hemorrhage. Less hemorrhage in the field of operation not only dispenses with continuous sponging, which is necessary when a general anesthetic is employed, but the operator can be more technical and thorough with the operation.

The amount of the vaso-constricting agent varies somewhat with the nature of the operation; 1/1,600 of a grain of synthetic suprarenin or adrenalin per mil of the injecting solution is sufficient for practically every oral or dental operation. For operative dentistry, one minim of a 1/1,000 solution of adrenalin added to two mils of the injection solution, or 1/3,200 of a grain is sufficient in most cases. If it is necessary to maintain anesthesia for a longer period of time, 2 minims of a 1/1,000 solution can be added per mil, or tablets containing the proper amount can be added to the injecting solution. An amount exceeding 1/1,600 of a grain per mil is employed for operations extending over considerable time. A solution of 1/1,000 or even 1/3,000, can be applied directly to the part, while operating, upon gauze held by an applicator, which will cause vaso-constriction of the vessels in the part, thereby controlling the hemorrhage. (See chapter on preparation of injecting solutions.)

SUPRARENIN IN COMBINATION WITH A LOCAL ANESTHETIC

It is well to emphasize that the addition of suprarenin to the local anesthetic solution reduces the toxicity of the anesthetic drug, as the vaso-constriction restricts rapid absorption. The anesthetic drug enters the circulation very slowly, and this being the case a greater amount can be injected when combined with the vaso-constricting agent. For example, a cocain solution introduced quickly into the circulation will produce toxic symptoms, whereas the same amount of solution can be diluted and injected, covering a longer period which produces slight or no toxic symptoms. This should be conclusive evidence of the efficiency of the suprarenal extract not only in materially reducing the toxicity of the anesthetic drug, but in addition bringing about a more intense anesthetic action, less hemorrhage, and the duration of anesthesia is from three to ten times longer when it is employed.

Local ischemia, which is produced by the suprarenin has proved of immeasurable value to the oral surgeon, dentist, laryngologist and rhinologist in controlling hemorrhage. A solution in the strength of 1/1,000 to 1/5,000 applied directly to the mucous membrane of the throat and nose diminishes turgescence, and produces contraction, which renders the nasal tissue more accessible for observation and operating.

TOXICITY OF SUPRARENIN

The primary toxic symptoms manifested by the patient are as follows: (1) malaise, fear, dread or anxiety. (2) Labored respiration is one of the first symptoms which is almost always accompanied by palpitation of the heart. (3) The patient may complain of fullness in the chest and head and will many times remark about the throbbing of the blood vessels in the head. (4) Pallor rapidly spreads over the patient's face and in some cases a deep anemia prevails.

Paleness first presents itself in the lips, rapidly spreading over the face. Occasionally, following an injection, especially the facial nerve block injections, the tissue in the immediate region will become extremely pale. When this anemia appears at a point distant, say several inches from the injection, it is due to a small amount of the suprarenin entering the circulation. The author has experienced this condition in a few cases, but has felt no alarm. It is also due to a hypersusceptibility of the patient, the rapid diffusion and quick absorption of the solution.

It must be remembered that the toxic symptoms developing during or immediately following the injection may be due to the action of the vaso-constricting agent, or may be due to the action of the cocain, procain, or whatever anesthetic is employed, or may be due to a combination of factors. In most cases the symptoms pass off very readily. (The reader is referred to Chapter XXXVI on Syncope, Shock and Collapse for further discussion of this subject.)

DOSAGE AND MODE OF APPLICATION

Adrenalin and synthetic suprarenin are employed in both solution and tablet form. Tablets for local anesthesia should never exceed 1/1,200 of a grain. The author has found, after experiments in the clinic and laboratory, that 1/1,600 of a grain per mil is the ideal amount to employ in the majority of cases when all factors are considered, in practically all operations for oral surgery, dental and throat operations. In many cases 1/3,200 gr. per mil is also advantageous. (See Chapters XV and XX.)

Anesthetic tablets which exceed 1/1,200 of a grain of suprarenin should never be used for deep block anesthesia, especially when it is necessary to inject several mils of the solution.

The suprarenin exerts a very powerful action upon the circulatory apparatus in producing an increased blood pressure, and even when administered in solution of one to one million it will produce a slight local ischemia. If the 1/1,000 solution is to be used, it can be freshly prepared from tablets or obtained in amber colored, alkaline-free bottles. Five to seven minims is the maximum dose. However, this amount must be injected with caution if the individual manifests a pathologic condition wherein high blood pressure would be contraindicated. Examples of such pathologic conditions are aortic regurgitation, mitral insufficiency, Graves' disease, diabetes, and arteriosclerosis. However, five to seven minims can be injected safely into the normal healthy adult. The therapeutic dose differs in accordance with: (1) dilution, (2) the extent of the area over which it is distributed, and (3) the manner and rapidity of injection. For example, five to seven minims of a 1/1,000 solution injected into the circulation is the maximum dose in a healthy individual, whereas the same amount in the local anesthetic solution can be safely injected in most individuals for deep nerve blocking or terminal anesthesia, in view of the fact that it is not injected into the blood stream, but is slowly absorbed and enters the circulation gradually.

The dose of adrenalin or synthetic suprarenin must be given in accordance with the physical condition and age of the patient, the area of injection and distribution. Patients who manifest a pathologic condition in which a high blood pressure is apparent, seem to be more susceptible to the action of suprarenal extract than a healthy individual; therefore, care should be exercised while making the injection and operating on such patients.

The writer has, with several healthy individuals, injected as high as 25 mils of procain, suprarenin, Ringer solution, each mil containing 1 3 of a grain of procain, 1 1,600 of a grain of synthetic suprarenin, and Ringer's constituents. Twenty-five cubic centimeters would make 8 1 3 grains of procain, and 1 64 of a grain of the vaso-constricting agent. This quantity of solution was slowly injected, and strict observance was made of the respiration and pulse. The blood pressure was taken and the injections were made with the patient in a horizontal position. If it is necessary to inject a large quantity of solution, the operator should always keep a close watch on the patient for any approaching toxic symptoms. The best key to the situation is a strict observance of the pulse and blood pressure.

The author will quote Prinz as to dosage of epinephrin, 1 1,000 solution. The dosage of the relative amount of epinephrin (adrenalin) solution may be arranged as follows:

Add 1 drop of epinephrin to 1 c.c. of the procain solution
2 drops of epinephrin to 3 c.c. of the procain solution.
3 drops of epinephrin to 5 c.c. of the procain solution.
4 drops of epinephrin to 8 c.c. of the procain solution.
5 drops of epinephrin to 10 or more c.c. of the procain solution.

SOLUTION PREPARED FROM TABLETS

A solution can be made from synthetic suprarenin or adrenalin tablets which can be secured containing various amounts of the drug. These tablets are added to sterile distilled water. Take, for example, the synthetic suprarenin bitartrate tablet. Each tablet contains one milligram and, when added to one mil of sterile distilled water, makes a fresh 1 1,000 solution. If a stock solution is desired, add ten tablets to ten mils of sterile distilled water; then add one minim of dilute hydrochloric acid and bring to the boiling point. Before the suprarenin tablets are added, the distilled water should be boiled for several minutes to insure its sterility. This solution is then added to the local anesthetic vehicle as above given for 1 1,000 adrenalin solution.

Local anesthetic tablets in which suprarenin is present are preferred in preparing the local anesthetic solution for the following reasons:

1. The injecting solution can be quickly prepared when needed.

2. It is a convenient and accurate method.

3. A fresh solution is prepared, which contains the desired amount of procain and suprarenin.

The author's meth -Ringer tablet to one
mil of sterile two per

cent procain and 1/25,000 solution (1/250 per cent) of the vaso-constricting agent, and a fresh physiologic, isotonic Ringer solution, all at the same time.

Were it not for the addition of suprarenin to the anesthetic solution, the following conditions would occur:

1. A profound anesthesia would be difficult to secure.
2. Excessive hemorrhage would be present in the operative field.
3. The anesthetic drug would be quickly absorbed, making it impossible to inject as much as when it is combined with the vaso-constricting agent, due to the toxicity of the local anesthetic.

The value of the vaso-constricting agent may be summarized thus:

1. It prolongs the duration of anesthesia from three to ten times.
2. It lessens the toxicity of the local anesthetic with which it is combined.
3. It reduces or prevents hemorrhage.
4. It intensifies the action of the local anesthetic.
5. It lessens the rate of absorption.

CHAPTER XVII

COMPARATIVE ACTION OF VARIOUS LOCAL ANESTHETIC AGENTS

The research on toxicity of various local anesthetic agents carried on by Dreyfus and Piquand has been very exhaustive and is of inestimable value. Their first experiments were with different percentages of stovain and cocain and were performed in 1907. The first report of their research was made to the Society de Biologie.

The following has been compiled by Dr. Carroll Allen and published in his textbook entitled "Local Anesthesia." This research work was carried out by Piquand and Dreyfus, and also appeared in the *Jour. Phys. et Path. Gen.*, January, 1910, and the results of their labors which should prove of great value to the reader:

"Comparing cocain with stovain on peripheral nerves and on the cornea of animals, they found that in the same strength and quantities stovain was slower in action and of shorter duration than cocain—twenty minutes as compared to twenty-five. Comparing tropococain with alypin in the eye of animals, it was found that with equal quantities of the same strength solution alypin was slightly slower in action and of a somewhat longer duration than tropococain—twenty minutes as compared to fifteen. The eye treated with alypin was slightly inflamed for forty-eight hours afterwards.

"Comparing cocain with stovain injected intradermally gave about the same comparative results as when used on peripheral nerves or in the cornea. Comparing tropococain with alypin intradermally, tropococain anesthesia (1 per cent) takes place immediately and persists nineteen to twenty minutes.

"Alypin (1 per cent) anesthesia at the end of two to three minutes and lasted twenty to twenty-two minutes, the skin remaining red and painful for several hours afterwards. Novocain (1 per cent) gave immediate complete anesthesia for twenty minutes. Novocain (5 per cent) with one drop of adrenalin solution (1 per cent per cubic centimeter) gave an immediate anesthesia with anemia that persisted a very long time. At the end of one hour the skin was insensitive to pricking and pinching.

"In clinical use cocain (1:200) in Reclus' solution produced anesthesia after two to three minutes, lasting fifty to sixty minutes; 1 per cent solution gave an anesthesia lasting eighty to ninety minutes.

"In less concentrated solutions (1:400) anesthesia was obtained in six to seven minutes, but was often incomplete, its effect passing off after twenty to thirty minutes. A solution of 1:1,000 as recommended by Schleich, gave unsatisfactory results. Solution 1:200, when kept in prolonged contact with mucous membranes, produced anesthesia. Stovain in clinical use in equal strength as cocain was found to be less effective and of shorter duration. M. Billon found 0.72 per cent solution of stovain equal to 0.5 per cent solution of cocain.

"Stovain in pure watery solutions was often found to be painful and the development of anesthesia somewhat delayed; in physiological salt solution its action was more prompt. To augment the degree and duration of the action of the stovain solution, Billon recommends either the combination with cocain or alcohol:

	Gm. or Mil	
Stovain		50
Alcohol (90 per cent)	20	
Aqua dest.	75	

"Anesthesia produced by this solution is superior to that of stovain in pure watery solutions, but clearly inferior to cocain in 0.05 per cent solutions.

"Clinical experiments with beta-eucain showed it to be less active and of shorter duration than that produced by cocain.

"In clinical experiments tropococain was found to produce a slightly longer anesthesia than stovain. Novocain was found to possess anesthetic properties superior to stovain and tropococain and almost equal to cocain. In pure watery solution of 5 per cent it was very slightly painful, but not at all so in normal salt solution; its anesthesia was of short duration, about twenty-five minutes.

"In two patients operated upon, in whom one-half the field was anesthetized with cocain and the other half with novocain, each 1:200 solution, the following observations were made: The injection of each was painless; in the field infiltrated with cocain the anesthesia appeared slightly quicker than the half infitrated with novocain; in one there was no difference in the intensity of the anesthesia; in the other there was a slight difference in favor of cocain; in each the anesthesia was slightly longer in the cocain half of the fields.

"In several patients anesthetized partly with stovain and partly with novocain, each 1:200 solution, the injections of stovain were always slightly painful, while the novocain injections were always painless, more rapid and more complete in action, but the stovain anesthesia was maintained slightly longer.

"Two patients anesthetized partly with novocain and partly with cocain-stovain (in equal parts), each presented a perfect, complete anesthesia, but more durable in the cocain-stovain field.

"A patient, anesthetized one-half the field with novocain and the other half with tropococain 1:200, presented an anesthesia more complete with novocain, but more durable with tropococain.

"To augment the durability of novocain anesthesia, Reclus has suggested the following:

Normal salt solution	100 grams
Procain (novocain)	50 centigrams
Adrenalin (1:1,000 solution)	20 drops

"With this mixture, in an experience of over 300 cases, anesthesia was immediate, complete, and lasted usually more than an hour."

"The comparative value of the agents experimented with is given as follows:

"1. Cocain, the most efficient.

"2. Novocain-adrenalin, nearly equal in power, to cocain, but more durable.

"3. Novocain, alypin, and cocain-stovain in equal parts; these three have an anesthetic power nearly equal but less durable than novocain.

"4. Stovain, tropococain, beta-eucain; these three about equal.

"A. By injecting into the vein of a rabbit weighing 2 kg. a solution of cocain 1:200 in such a way as to control the flow to 5 c.c. per minute, the animal died when it had received 15 cg. of the alkaloid or 6 cg. (0.4) per kilogram of weight.

"B. By increasing the flow to 10 c.c. per minute in a rabbit weighing 9 kg. death occurred when it had received 9 cg. of the alkaloid or 4 cg. (0.2) per kilogram of weight.

"C. By diminishing the flow to 5 c.c. per two minutes in a rabbit weighing 3 kg. death occurred when the animal had received 20 c.c. of the alkaloid or 9 cg. per kilogram.

"Similar experiences were had with cocain, stovain, and tropococain, and demonstrate the law given by Reclus that the toxicity of the drug depends upon the quantity introduced into the circulation and reaching the central nervous system at the same time.

"By administering the drug in interrupted doses or by delaying its absorption, it is possible to administer three or four times the toxic dose without injury.

"Novocain was one-third as toxic as stovain and one-sixth as toxic as cocain. What was particularly important was that novocain-adrenalin was notably more toxic than novocain alone only in intravenous injection, but was not more toxic in intraperitoneal injection.

"Subcutaneous injections on various animals show that novocain-adrenalin is not appreciably more toxic than novocain alone.

"**Action on the Tissues.**—Cocain when injected into the tissues causes no pain or inflammation and is absorbed without leaving behind any trace of its action. When instilled into the eye it causes no pain or alteration in the cornea. It has a marked vaso-constrictor action.

"Concentrated solutions, when instilled into the eye, cause a momentary burning pain. This is more marked with some preparations than with others, and is probably due to slight differences in the method of manufacture.

"Stovain, when instilled into the eye, caused a marked sensation, as of a foreign body, lacrimation and photophobia, the vessels becoming injected with moderate contraction of the pupil. Injected intradermally and subcutaneously, it provokes pain lasting two to three minutes.

"The lacrimation, photophobia, and congestion produced by the instillation of stovain in the eye, and when injected into the tissues, the pain and vasodilation indicated an irritation due to its acid reaction.

"Beta-eucain, injected subcutaneously, causes a sharp pain which lasts several minutes. Instilled into the eye, it causes lacrimation, photophobia, and a persistent redness. These phenomena of irritation are notably more marked and more durable than with stovain.

"Tropococain, when injected into the tissues, is not irritating and has no effect upon the vessels. Instilled into the eye of the rabbit, it causes a slight lacrimation and redness of the conjunctiva.

"Alypin is extremely irritant; intradermal injections of 1 per cent solution are painful, and accompanied by marked redness and vaso-dilatation. Following the injections, the tissues remain painful and infiltrated for a long time. Five per cent solutions are extremely painful, and may be followed by gangrene. Instilled into the eye in 5 per cent solutions, it causes pain, lacrimation, photophobia, redness of the conjunctiva, and transient paralysis of accommodation.

"Novocain does not appear at all irritant; with injections of 0.5 or 1 per cent there is no vaso-constriction or vaso-dilatation and leaves no after-effect upon the tissues. Injections of ten per cent are slightly irritant and produce slight congestion of the tissues; this rapidly disappears and does not leave behind any appreciable lesion. Applied to the mucous membranes on tampons it produces a rapid anesthesia without any disturbing effects upon the tissues. When instilled into the eyes it causes no disturbance; if a little of the pure drug is dropped on the cornea it causes a slight irritation of short duration; if pure cocain is dropped on the cornea it produces pronounced disturbances.

"Novocain and adrenalin (1:200 with one drop of adrenalin solution 1:1,000 to each 2 c.c.) does not appear to be more irritating than novocain alone, and cause no disturbance either at the time of the injection or afterward. With the adrenalin it produces prolonged anesthesia and a pronounced vasoconstriction, lasting for several hours. The conclusions were drawn from an experience of over 300 cases. In this series there were, however, 3 cases of gangrene which occurred during a change of staff, and it is presumed was due to some error in the technic of sterilization or preparation of the fluid, as no similar cases have been reported, except two cases by Strohe (*Deutsche Zeit. f. Chir.*, T. x, C.T. x, p. 264). In these 2 cases the quantity of adrenalin was very large.

"From the above observations the following conclusions were drawn: Cocain is the most powerful of all local anesthetics, but its high toxicity renders it dangerous; a safe dose should not exceed 14 to 15 cg. in 1:200 solution, care being taken to maintain the recumbent position during and after its use.

"Six cases of death occurred from the use of cocain, in one the dose was 28 cg. of 2 per cent solution.

"Beta-eucain appears to present no advantage over cocain; it is equally as toxic, much less anesthetic, and more irritant.

"Alypin should not be prescribed in view of its toxicity and irritating qualities.

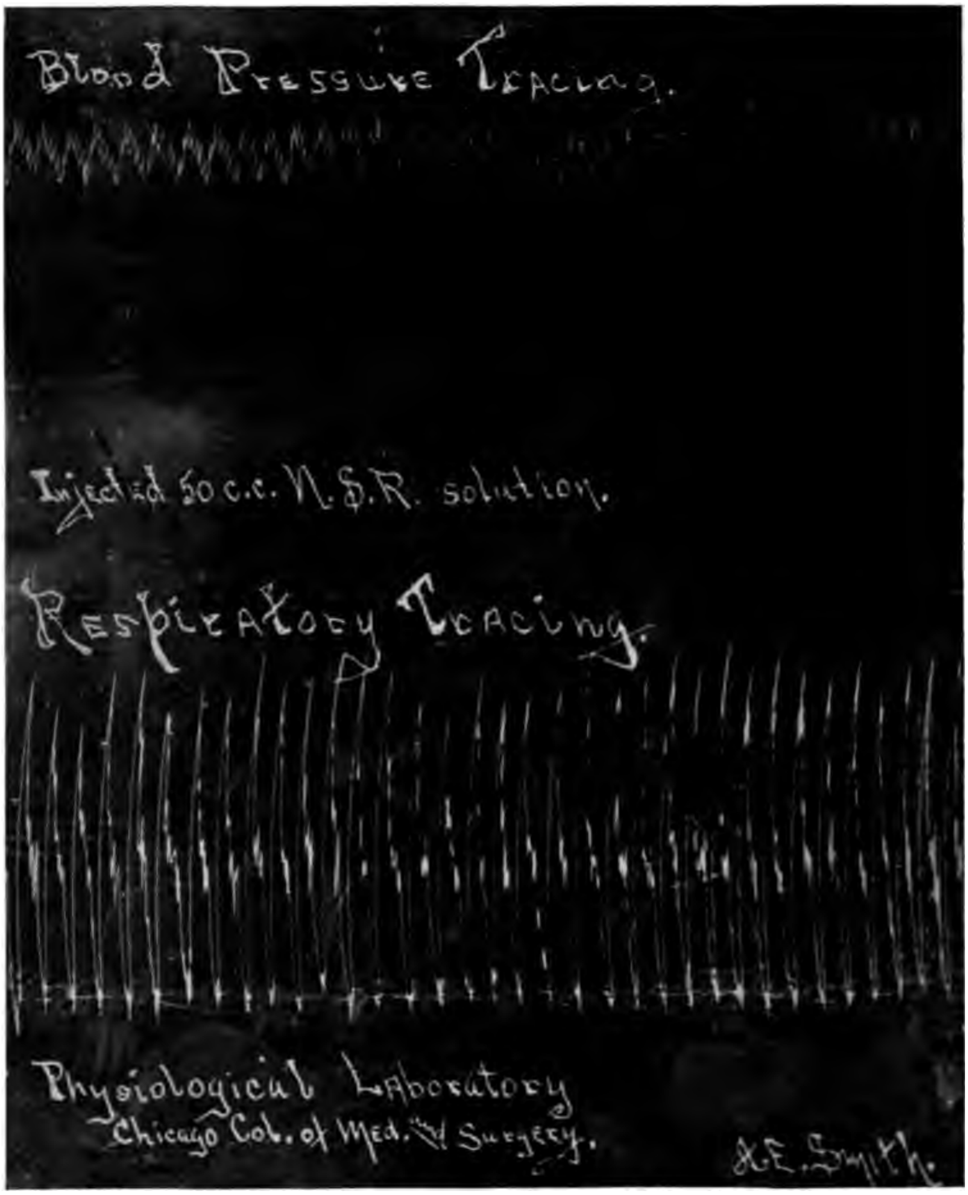


Fig. 145.—Kymographic tracing, illustrating normal blood pressure and respiration on a dog after injecting 50 mils of a 2% solution procain, 1/25,000 solution suprarenin and a fresh isotonic Ringer solution as a vehicle. The solution was injected into the mucous membrane of the mouth and throat of the dog.

"Stovain presents considerable advantage over cocain; it is one-half as toxic, and a safe dose is placed at 30 cg. of a 1:200 solution, but this dose was exceeded several times, reaching as high as 37 cg. without observing any trouble. Precautions are notably less important than with cocain.

"The irritant action following its use and its weaker anesthetic power can be largely overcome by using it in normal salt solution and in slightly greater strength.

"**Tropococain.**—Little clinical experience was had with this alkaloid, but it appears to be a good anesthetic. Judging from the experimental results, its toxicity and anesthetic value are very close to those obtained with stovain-cocain.

"**Novocain.**—This appears at the present time the most commendable of local anesthetics; its feeble toxicity permits large doses to be used without inconvenience; it has considerable anesthetic power, is nonirritant, and not a vaso-dilator. The only inconvenience is that its action is comparatively a little shorter than cocain, but this can be overcome by the addition of adrenalin, which produces a prolonged anesthesia of slightly more marked degree without increasing its toxicity."

RESEARCH BY THE AUTHOR

The injecting of a solution containing an unknown anesthetic should never be practiced. There are many ready-made solutions of secret formula upon the market, and it is safe to say that cocain is the basis of many of them. However, since the advent of the Harrison Narcotic Law this practice has been stopped.

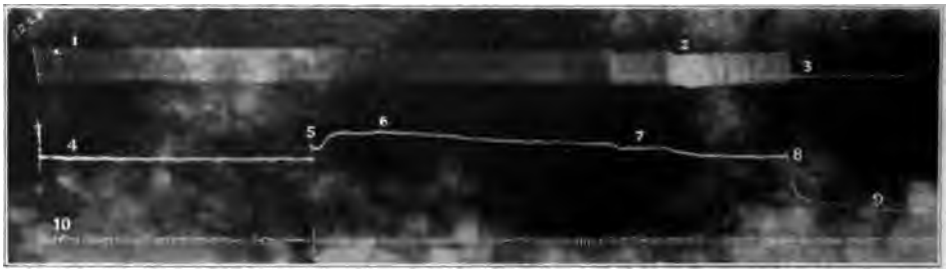


Fig. 146.—Kymographic tracing, illustrating blood pressure and respiration using a cocain solution as the local anesthetic. (Experiment performed upon a dog.)

1. Normal respiration; 2, acceleration of respiration; 3, cessation of respiration; 4, normal blood pressure; 5, injection of 6 mils of a 2 per cent cocain solution; 6, showing rise in blood pressure; 7, gradual decrease in blood pressure; 8, cessation of heart beat; 9, excessive drop in blood pressure and death of animal; 10, time recorded by electric clock.

During the year 1915 the writer started research work with local anesthetics in the Physiological Laboratory of the Medical Department, Loyola University, Chicago, under the personal direction of Professor W. D. Zoethout. The object of this laboratory research was to determine the toxicity of different local anesthetics which are on the market today. Solutions of different percentages were injected into animals under different conditions, and the result on blood pressure, respiration and circulation was recorded by the kymograph. At this writing this work has not been completed, and it is the writer's intention to test all the principal local anesthetic preparations, both official and proprietary, and subject them to the most exacting tests.

The first report of this work was given by the writer in 1915 in a paper read before the Panama Pacific Dental Congress, San Francisco, and published later in the *Dental Items of Interest.*

When this research is completed, it will undoubtedly be of interest and value to those who are interested in local anesthesia and research work. The kymographic tracings shown on pages 279, 280 and 281 have been taken from the collection which are quite interesting.

The Therapeutic Committee, British Medical Association, made a comparative study of various local anesthetics as to their toxicity, and as their standard they used cocain which was represented by 1. Their report is as follows:

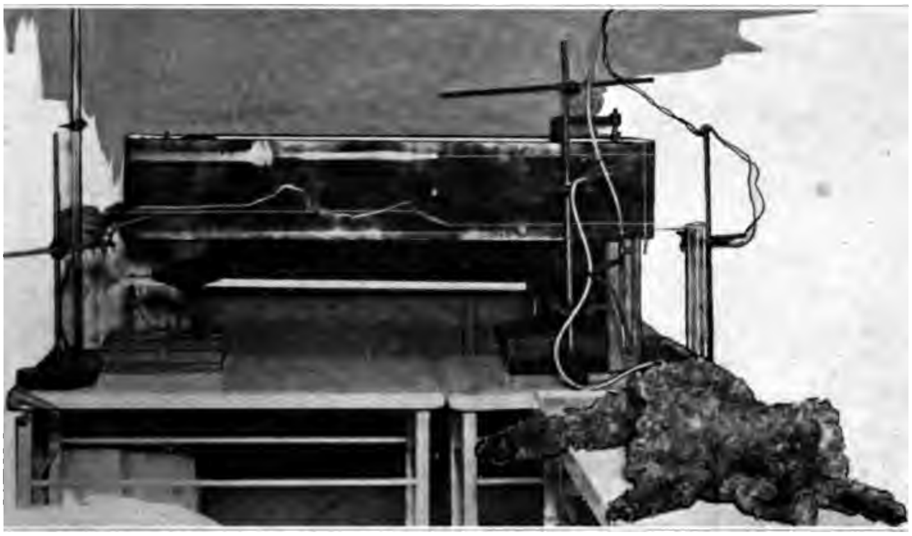


Fig. 147.—Illustrating kymograph, and showing an experiment upon a dog with a local anesthetic solution. Upper line on tracing shows effects on respiration; lower line shows increase and fall of blood pressure.

Cocain	1.000
Alypin	1.250
Beta-eucain lactate	0.414
Novocain	0.490
Tropococain	0.500
Stovain	0.625
Nirvanin	0.714

The toxicity of cocain and its substitutes depends on the following factors:

1. The percentage of the solution injected.
2. The quantity of solution injected.
3. The rapidity with which the solution is injected.

4. The rate of absorption into the general circulation.
5. The idiosyncrasy of the patient.

If a quantity of a solution of high percentage, sufficient to cause death when rapidly injected into the circulation, is well diluted and injected subcutaneously, it may produce slight or no toxic symptoms. In other words, if absorption is slow, or if the drug is injected very slowly and extending over considerable time, little or no toxic effects will develop.

The author will quote Eggleston and Hatcher, from the Department of Pharmacology, Cornell University Medical College. The results of their research work appeared in the *Journal of the American Medical Association,* October 25, 1919, entitled "The Pharmacology of Local Anesthetics."

"Acute intoxication in man from the use of the local anesthetics is far more common than is indicated by the number of recorded cases. We undertook to investigate the causes of such intoxication, and sought to find means of avoiding it, or combating it when it arises. This investigation has included a study of the literature of the more important cases of human intoxication, and the performance of over 300 experiments on cats. The details of this work are published elsewhere, the present communication being limited to a short discussion of the more important facts brought to light, especially with reference to their bearing on the clinical problem.

"Nine of the local anesthetics were studied, and the maximum toxicity of each was determined by rapid intravenous injection into cats. The drugs used, the fatal dose of each, the concentrations of the solutions employed, and the relative toxicities of the drugs are shown in the accompanying chart. From the chart it is seen that cocain is about intermediate in the group with reference to its maximal toxicity for the cat. These relative toxicities, however, apply only for single doses injected rapidly into the blood stream. When large fractions of the minimal fatal doses are injected intravenously at intervals of from fifteen to twenty minutes, or when relatively dilute solutions of the drugs are injected slowly and nearly continuously, the several drugs can be divided into two groups based on the difference in their rates of elimination. Group 1 includes alypin, apothesin, beta-eucain, nirvanin, procain (novocain), stovain and tropococain, all of which are rapidly eliminated, so that several times the minimal fatal dose of any of these can be injected in the ways just mentioned in periods of one or two hours without causing death of the animal. Group 2 includes cocain and holocain, which are much less rapidly eliminated, and which therefore cause death in much smaller total doses when given as described.

"When injected subcutaneously into cats, the local anesthetics can again be divided into the same two groups, depending on their rates of elimination. All are apparently absorbed rapidly, but those of Group 2 are much more toxic by subcutaneous injection than those of Group 1 because their elimination is not rapid enough to keep pace with their absorption. Five or more times the minimal fatal vein dose of any of the members of Group 1 can be injected subcutaneously without causing death, while less than four times the fatal vein doses of those of Group 2 prove fatal.

"When absorption from the subcutaneous tissues is delayed by the simultaneous injection of epinephrin, the difference between the two groups is emphasized, and the toxicity of the members of the first group is reduced far more than that of the members of Group 2. The elimination of members of Group 1 proceeds at the rate of at least one fatal vein dose every twenty minutes, while not all of a subcutaneous dose of cocain, one and one-third times that fatal by vein, may be eliminated in twenty-four hours or more.

"The elimination of all of the local anesthetics is accomplished almost entirely by their destruction in the liver, as can be demonstrated by perfusion of the excised, surviving organ with diluted blood containing large quantities of the drugs in solution, and subsequent determination of the amount remaining in the perfused fluid.

"Various efforts were made to influence the toxicity of the local anesthetics, including the administration of atropin or caffein prior to the intravenous injection of the anesthetics; the addition of sodium bicarbonate to the solution of the anesthetic just before intravenous injection, to liberate the base; the production of nervous exhaustion in the cat; severe acute hemorrhage by removal of one-fourth of the cat's total blood; and the production of narcosis by the administration of hydrated chloral. None of these measures had any influence on the cat's susceptibility to the intravenous injection of any of the anesthetics except acute hemorrhage and narcosis by chloral. Both of these caused some increase in the cat's susceptibility, as shown by the fact that often it succumbed to doses smaller than the average fatal dose. This increased susceptibility is accounted for by the fact that both of these measures interfere with the destruction of the anesthetics in the liver by reduction in the blood pressure and impair-

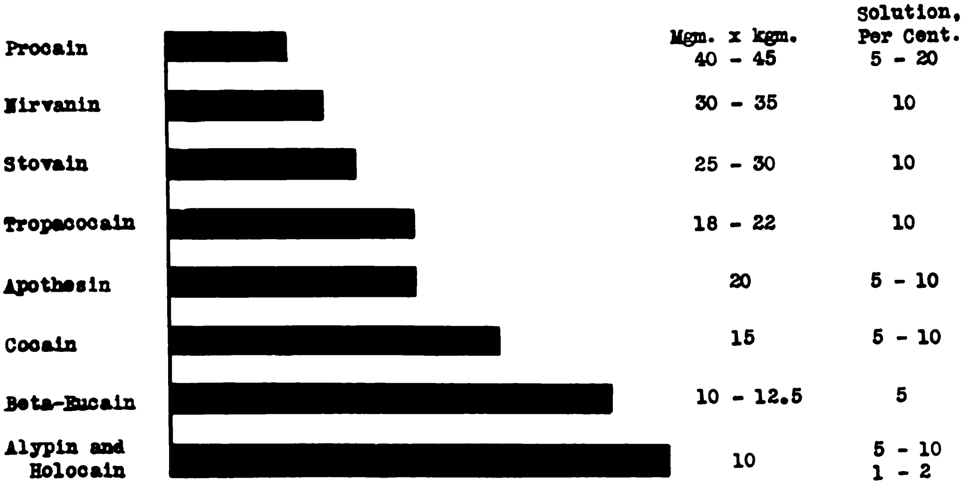


Fig. 148.—Chart showing comparative toxic action of local anesthetics. (Eggleston and Hatcher.)

ment of the circulation. The resistance of both the heart and the respiratory center is also probably reduced by the impaired circulation.

"The symptoms produced in cats by toxic doses of the various local anesthetics are essentially alike, and they are also essentially the same as those observed in man. All of these drugs kill by simultaneous paralysis of the heart and the respiratory center. We therefore tried artificial respiration in cats as a resuscitative measure, with and without cardiac massage, but it proved ineffective, even when combined with massage of the heart.

"The employment of artificial respiration in combination with stimulation of the heart by the immediate intravenous injection of epinephrin, however, enabled us to resuscitate the majority of cats after the rapid intravenous injection of doses of the local anesthetics up to twice the average fatal dose. Since the heart had stopped in most of the cats, it was necessary to practice massage of the heart in order to bring the epinephrin into contact with it. The success of this method of resuscitation depends on the rapid destruction of the local anesthetics, whereby the excess administered is promptly eliminated if the circulation can be maintained for only a few minutes by the stimulation of the heart with epinephrin. But even with such stimulation, and when it is evidently recovering, the animal will die of respiratory paralysis unless the center is supported for a few minutes by artifical respiration.

"The success of the preceding measures, in which the brief stimulation of the heart played the most important part, led us to try the effects of previous stimulation of the heart by the administration of a dose of ouabain (so-called crystalline strophanthin). We then administered doses of the local anesthetics up to twice the average fatal dose, and employed artificial respiration to tide over the period of respiratory paralysis. By these measures, cats usually survived doses of the anesthetics up to one and three quarter times the average fatal dose.

"It is evident, therefore, that if the circulation and respiration can be maintained for even a few minutes, the rapid destruction of the local anesthetics by the liver will care for amounts considerably in excess of those which are usually fatal. The close analogies between the behavior of man and cats to toxic doses of the local anesthetics, and the fact that man also recovers rapidly from the effects of nonfatal doses, suggest that he also accomplishes their elimination or destruction in the liver, and it seems highly probable that the use of epinephrin and artificial respiration will prove effective as resuscitative measures in many cases of acute poisoning in man. It is, however, to be remembered that serious intoxication has been seen in man following extremely small doses of the local anesthetics, suggesting the occasional existence of a marked degree of hypersusceptibility; and in such cases doses which are relatively small, as compared with the average commonly employed, may actually be several times the minimum which would be fatal in the particular individual, so that even the most effective resuscitative measures may well fail under such circumstances.

"While cardiac massage cannot be carried out so efficiently in man as in the cat, it can be performed sufficiently to cause the greater part of an intravenous injection of epinephrin to reach the heart; and several satisfactory methods are available for carrying on artificial respiration in man. These measures, also, are all such as can be applied without loss of time under most conditions, and they certainly seem to be the most effective means at our disposal for saving life after the development of symptoms of acute intoxication by the local anesthetics. Since acute poisoning in man occurs when least expected, those who frequently employ these local anesthetics should always be prepared to apply the three resuscitative measures of intravenous infusion of epinephrin, artificial respiration, and cardiac massage. All three should be used in combination, since no one alone is effective, except in rare instances.

Finally, in order to diminish the likelihood of intoxication from the subcutaneous injection of the local anesthetics—especially those of Group 1—in man, epinephrin should be added to their solutions as a routine, because by delaying their absorption it renders it more probable that the destruction by the liver can keep the amount present in the circulation at any one time at a point below that sufficient to cause intoxication. The use of epinephrin also has the further advantages of prolonging the anesthetic action of a given quantity of the drug and of reducing the amount required for anesthesia by permitting a larger proportion of the dose injected to remain in contact with the tissues to be anesthetized, and by maintaining the contact for a longer period of time than when the drug is injected alone."

CHAPTER XVIII

ARMAMENTARIUM FOR LOCAL ANESTHETICS AND ORAL SURGERY

In order that the operator may obtain the best results from the various forms of local anesthesia, it is very essential for him to equip himself with efficient appliances. If he attempts to make the various injections, especially the deep nerve block injections, with inefficient syringes, needles, solution, etc., he will not secure the best results. His efforts are not only likely to be attended with failure, but he will create anything but a favorable impression on the patient. Such failures will discourage the operator to an extent that he may be induced to cast aside so valuable a method as that of block anesthesia. He need not purchase unnecessary appliances, but it is essential for him to have all those things which go to make up an ideal local anesthesia outfit.

The reader will find the following list advantageous in the selection of appliances:

Syringes.

Hypodermic needles.

Local anesthetic tablets.

Still.

Flask for distilled water.

Fifteen-mil glass graduate (centrifuge type).

Two small size test tubes.

Ten-mil anesthetic tablet dissolving cup.

Three-mil anesthetic tablet dissolving cup.

Appliance for sterilizing distilled water for injecting solution and for rinsing the syringes.

Sterilizing jar.

Rack for sterilizing jar.

Germicidal preparation for making sterilizing solution.

Small glass receptacle for extra needles, burs, broaches, etc., which are submerged into antiseptic solution.

Porcelain or glass tray for reserve tablets, needles, etc.

Arkansas stone mounted on mandril for sharpening needles.

Glass or porcelain receptacle for iodin.

Wooden applicators.

Artery forceps.

Intraosseous double-bladed lancet and retractor.

Intraosseous guide. Intraosseous drill. Intraosseous needle. Gauze and cotton.

We shall now consider separately the above-named articles in the armamentarium.

The Hypodermic Syringe.—One of the most essential appliances in the local anesthetic armamentarium is a good working syringe. A syringe that leaks, or one that contains unsanitary washers, is not desirable, and with such an appliance it is impossible for the operator to know how much solution he is injecting. The development of the hypodermic syringe has been rapid during the past few years; however, there is yet a vast amount of room for improvement, inasmuch as all syringes presented to date have their disadvantages. An ideal syringe for block anesthesia should possess the following requirements:

1. It should stand boiling for the purpose of sterilization.
2. It should be free from unsanitary washers, threads and packing.

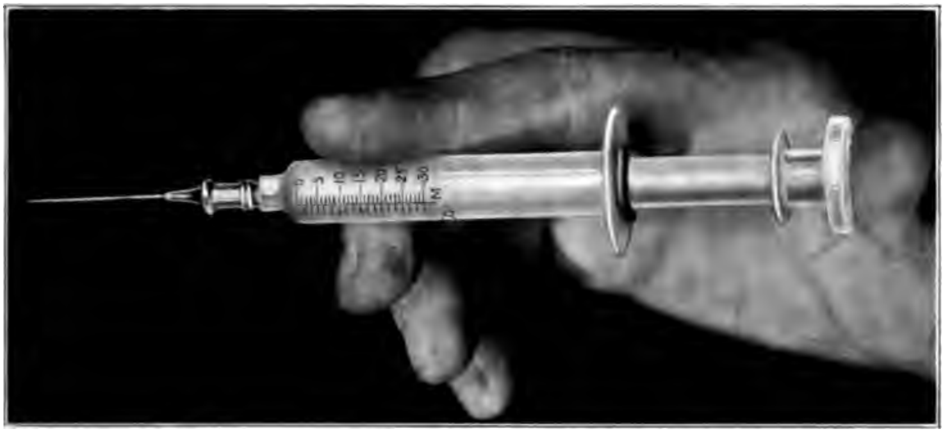


Fig. 149. Illustrating the manner in which the thumb is placed back of the plunger during process of discharging the solution.

3. It should not be complicated, but very simple in construction.
4. The plunger and barrel should be accurately ground so it will not leak while the solution is under pressure.
5. It should be short enough when filled so that the thumb can be brought behind the plunger to force out the solution without grasping the syringe with both hands.
6. It should be accurately graduated.
7. It should have a capacity of at least 2 mils.
8. The plunger should not stick while discharging the solution.
9. The needle tip or extension should be ground cone-shape, so that needles with a ground hub will fit accurately and can be quickly and easily changed.

It must be borne in mind that the smaller the diameter of the piston, the greater the pressure on the fluid, and a syringe of small diameter, holding enough of the solution for the average nerve blocking injection, would make the syringe entirely too long to manipulate easily with one hand, but a syringe of this type is of advantage if the solution is injected into dense tissue. However, for most block injections, it is well to remember that the greater number are made in loose connective tissue, and very little pressure is required while discharging the solution. The amount of pressure exerted in injecting into loose connective tissue for the purpose of blocking a nerve branch will seldom exceed three ounces; while, on the other hand, if the injection is made into tissues, such as the peridental membrane, gum tissue, or beneath the periosteum, considerable pressure is required. The operator must not expect too much of the hypodermic syringe, and he should always consider the amount of pressure he is exerting against the plunger and solution. He should use care in selecting syringes, and should see that the plunger works freely and does not catch while forcing the plunger into the barrel. He should also observe the accuracy of adaptation and fit between the needle hub and the syringe tip. If the ground needle hub does not fit the ground syringe tip accurately, there is a possibility of the needle coming off during the injection, and it is sure to leak at the joint.

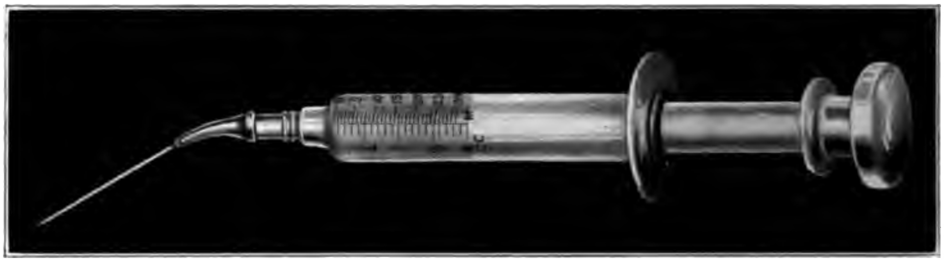


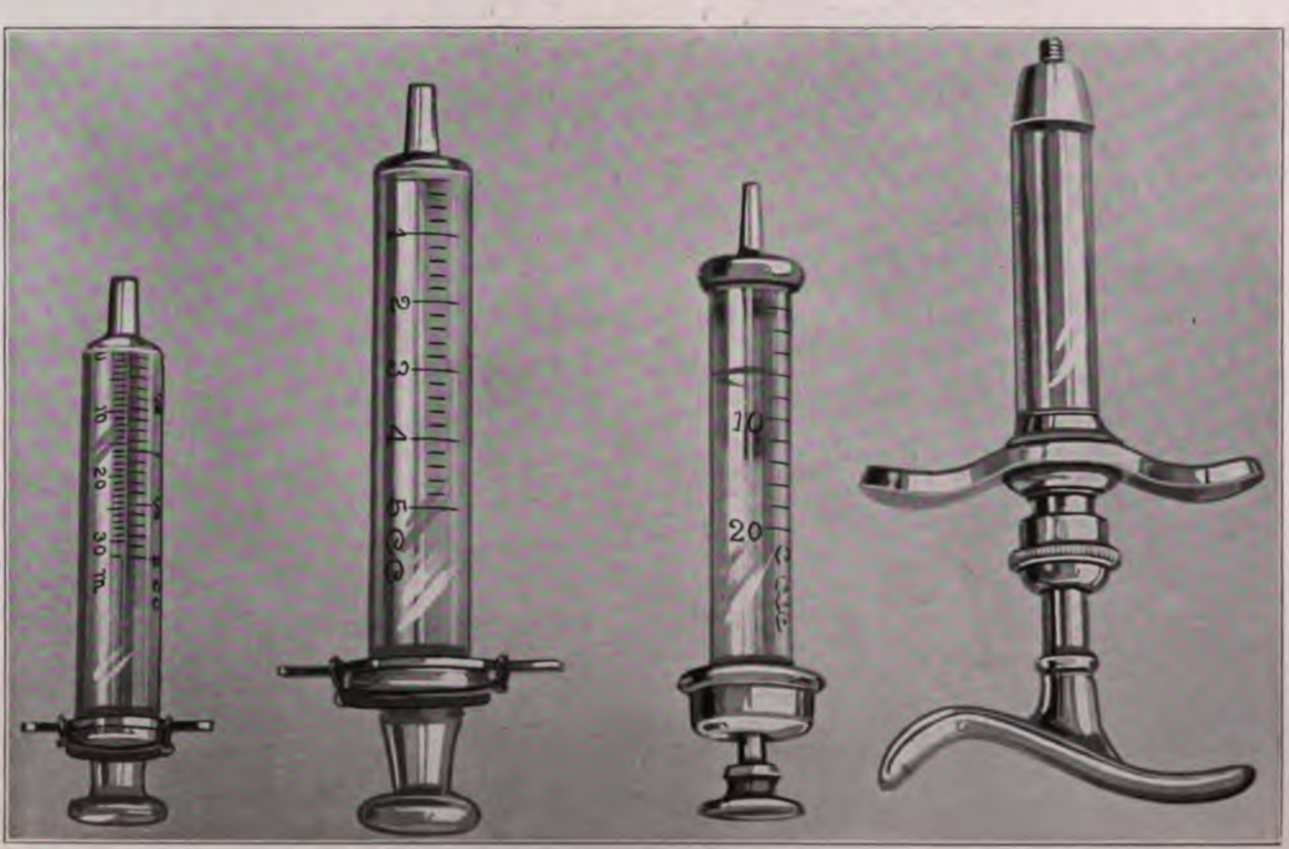
Fig. 150. All-glass syringe equipped with coil spring for retaining plunger.

When the syringes are not in use, they should be kept in the sterilizing solution in the sterilizing jar. To purchase syringe boxes is not advised; they are not only expensive, but unsanitary and worthless for office use.

The All-glass Syringe.—The all-glass syringe has its advantages and disadvantages. The principal disadvantage is that it is very easily broken either in use or during the process of sterilization in boiling water. Several all-glass syringes are on the market which are very good. The author employs a five-mil syringe for those injections requiring more than two and one-half mils of the solution, such as for the blocking of the second and third divisions of the fifth nerve, Gasserian ganglion, etc.

The All-metal Syringe.—An efficient metal syringe, which answers all purposes, has not yet been produced, and if the time ever comes when a syringe of this type is designed, it will have one drawback,—the operator will not be able to see the solution.

The advantages of an all-metal syringe are that it will not break and that it can be boiled indefinitely without fear of cracking, as is the case with the glass syringe. It is true that a glass syringe, or a combined glass and metal syringe, requires considerable attention, and the piston must always be re-



1. 2. 3. 4.

Fig. 151.—1. Two-mil all-glass Luer; 2, 5 mil all-glass Luer; 3, 2 mil metal and glass Record; 4, 20 minim all-metal Imperial.

moved while sterilizing in boiling water, whereas with the all-metal syringe, removing the plunger for boiling is not necessary. The constant breaking of glass syringes has led some dentists to purchase inefficient metal syringes now upon the market. A syringe that holds less than two mils is inefficient for deep nerve blocking injections. If a syringe having a smaller capacity than two mils is employed, it will be necessary either to insert the needle a second time or remove the syringe from the needle and refill it in order to inject the desired quantity for the blocking of some of the deeper nerve branches.

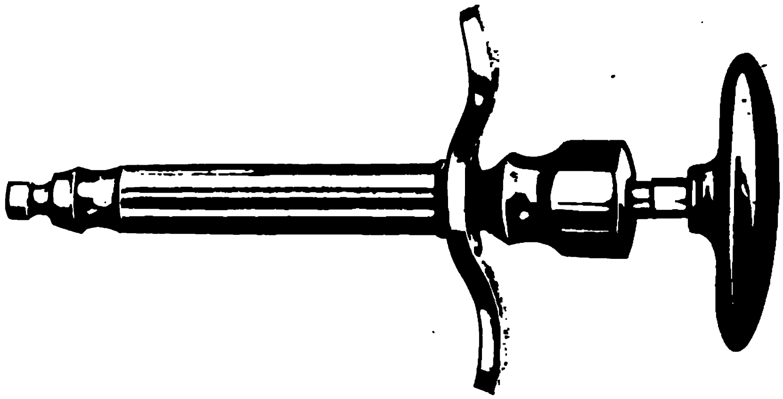


Fig. 152. -Imperial all-metal syringe. (20 minims.)

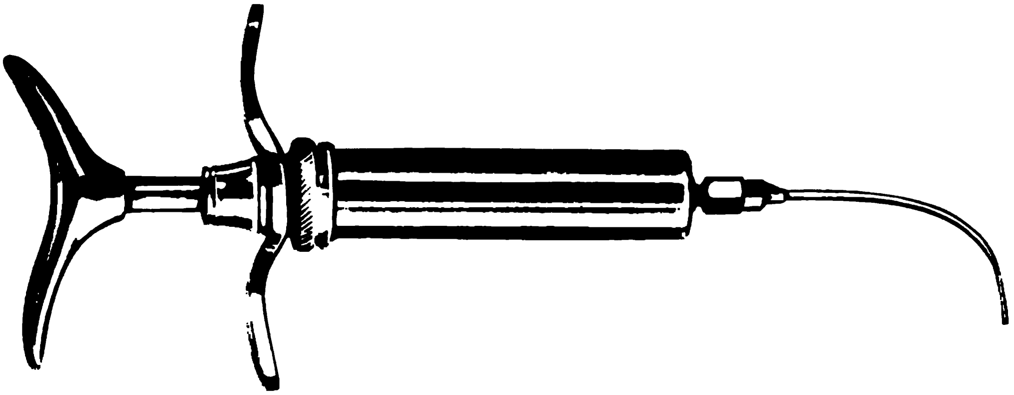


Fig. 153 All-metal syringe containing ground plunger and equipped with large flexible needle which is used for treating infected sockets, antrum, etc.

Combined Glass and Metal Syringe.—Within recent years several combined metal and glass syringes have been presented to the profession, and a few of them have been moderately satisfactory. However, they have disadvantages. With some of these syringes the glass barrel is enclosed in a metal frame, and tension is exerted upon the end of the barrel so as to prevent leakage. This tension has a tendency to weaken the glass so that it breaks easily. No doubt those who have been employing a syringe of this type will agree with the author in his experience that many broken glass barrels are not only very expensive to replace, but this accident may occur just at the time the operator needs the syringe.

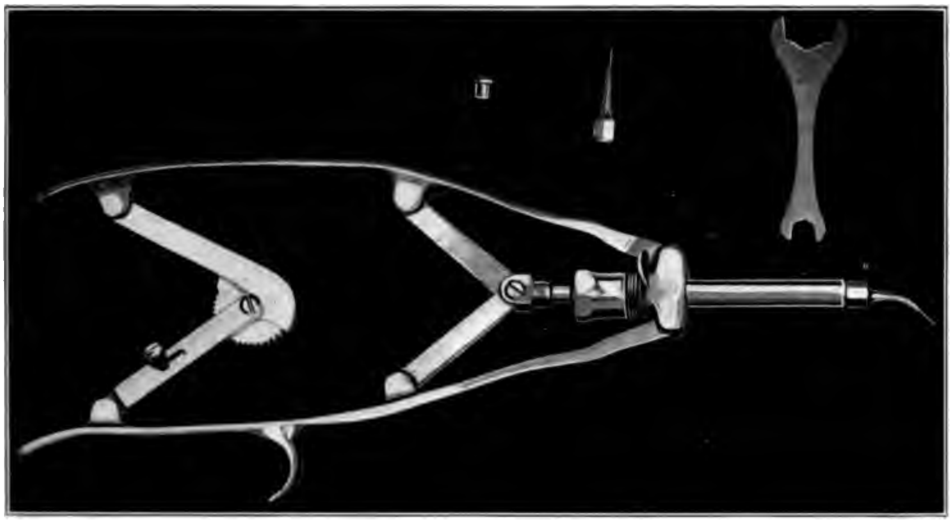


Fig. 154.—High pressure syringe and equipment. (Designed by Dr. C. G. Meyers.)

Considerable complaint has been made by the members of the profession regarding the inefficiency of the combination glass and metal syringe, especially in the breaking of barrels and in leakage. A well-made glass and metal syringe is valuable. In many cases the grinding has not been as perfect as it might be, the plunger sticking occasionally, and the metal plugs, which are inserted in the end of the barrel, have sometimes not been accurately ground, and such defects allow the syringe to leak. These drawbacks cause a great deal of dissatisfaction on the part of the operator. A syringe of this

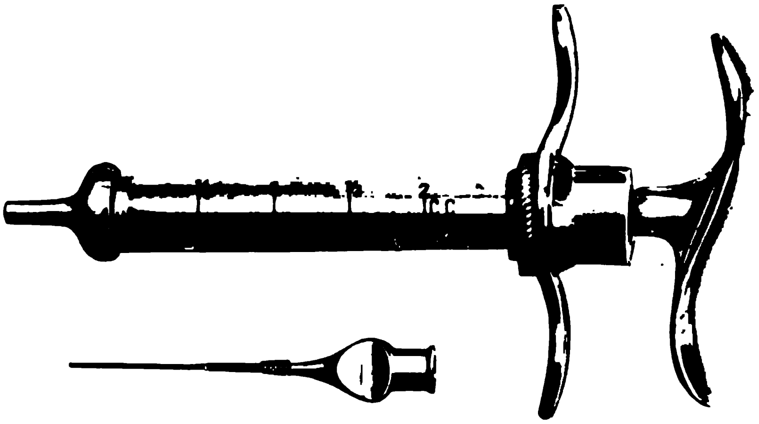


Fig. 155.—Block anesthesia syringe with plunger in position.

type, when boiled, must be taken apart. The glass barrel should be taken out of the metal frame and the plug removed from the end of the barrel. The glass barrel or glass syringe should never be placed in boiling water, but should be put in warm water, and then gradually brought to the boiling point. Some operators attempt to sterilize a syringe of this character with the plunger in the barrel and the barrel in the metal frame, which in nearly every case will result in fracturing of the glass due to expansion under heat. The needle tip of some of these syringes is threaded, which makes it necessary to screw on the hub and needle, which has the following disadvantages: ***First,*** the needles cannot be changed quickly; *second,* they are not as sanitary as the "slip on" hub; *third,* in case it is desired to inject a second time, retaining the needle in the tissue, it is extremely difficult to make the change.

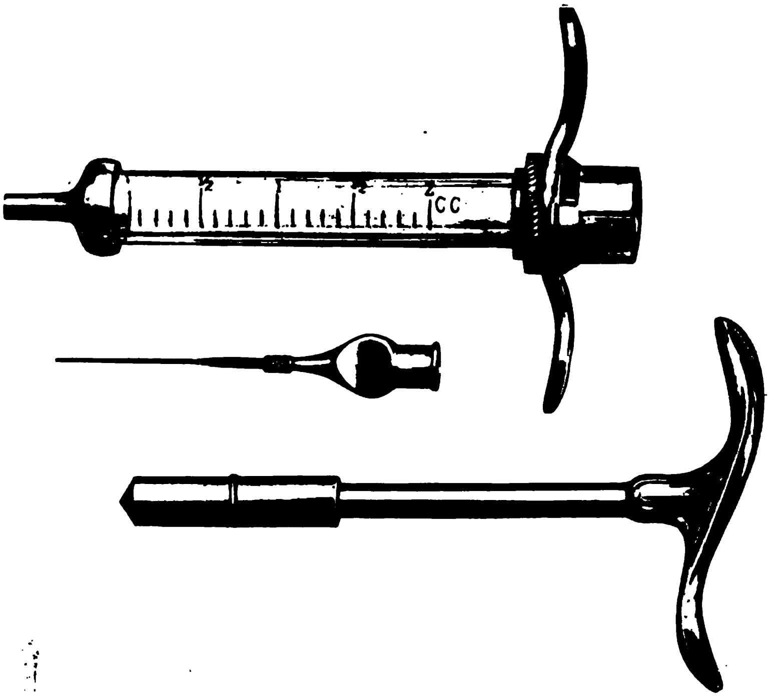


Fig. 156.—Block anesthesia syringe with plunger removed; also safety guard. (Designed by the author.)

Some metal and glass syringes are not retained in a metal frame, are more sanitary and less troublesome to sterilize and less breakage is encountered than with the glass barrel which contains a metal end piece and is retained in a metal frame.

The syringe tip, which is accurately ground cone-shaped, over which is placed an accurately ground needle hub, is preferable to the threaded tip or washers. Many operators prefer a joint of this character because the various needles can be quickly changed, a thing that cannot be done with the threaded tip; it is more sanitary, and in case a second syringeful is desired, the needle can be retained in the tissue, the syringe can be reloaded, and the tip can be easily slipped into the hub for injection. *If the tip on the syringe is cone-shaped and is properly ground, and the needle hubs are properly fitted, an accurate adaptation is secured, and the needle will not become dislodged during injection, and no leak occurs at the joint. In placing the hub of the needle over the ground tip it should be put on with a little twist, and if this is done, it is almost impossible to remove the needle without exerting a twisting or rotating motion.*

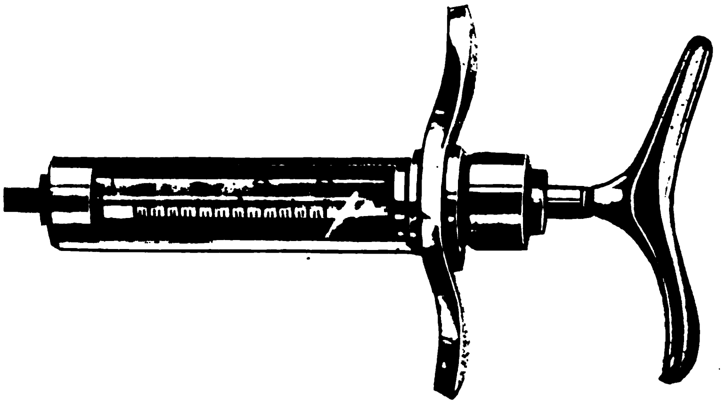


Fig. 157.—Local anesthetic syringe. (Designed by Dr. Fischer.)

A syringe employed for block anesthesia should, when filled, be short enough when the plunger is extended to manipulate it with one hand. The syringe should be held in the hand pen-fashion, and the thumb placed behind the plunger, gradually forcing the plunger down, thus discharging the solution continuously while the needle is being inserted into the tissue. (See Fig. 149.) The syringe is held in the right hand, if the operator is right handed, while the left hand takes care of the cheek, tongue, mucous membrane, and other tissues while the needle is being inserted in the proper location without having to grasp the syringe with the left hand. If necessary, the solution is slowly injected from

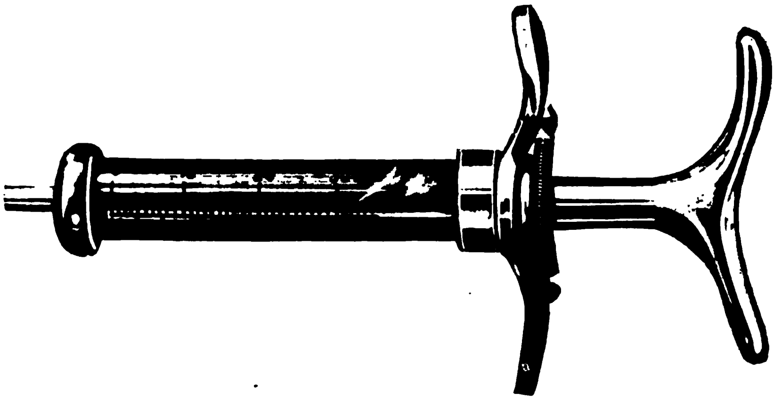


Fig. 158.—Combination metal and glass syringe, 2 mils. (Designed by the author.)

the time the point of the needle enters the tissue until the desired location has been reached. This is of advantage to the operator from the fact that the solution can be injected continuously from the time the point enters the tissue, so as to block all sensation in case the patient is hypersensitive.

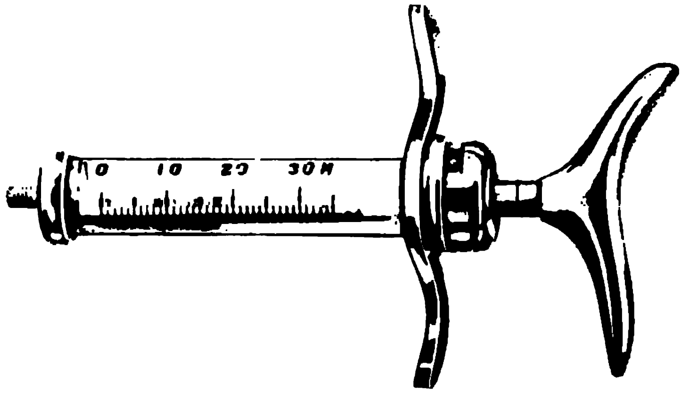
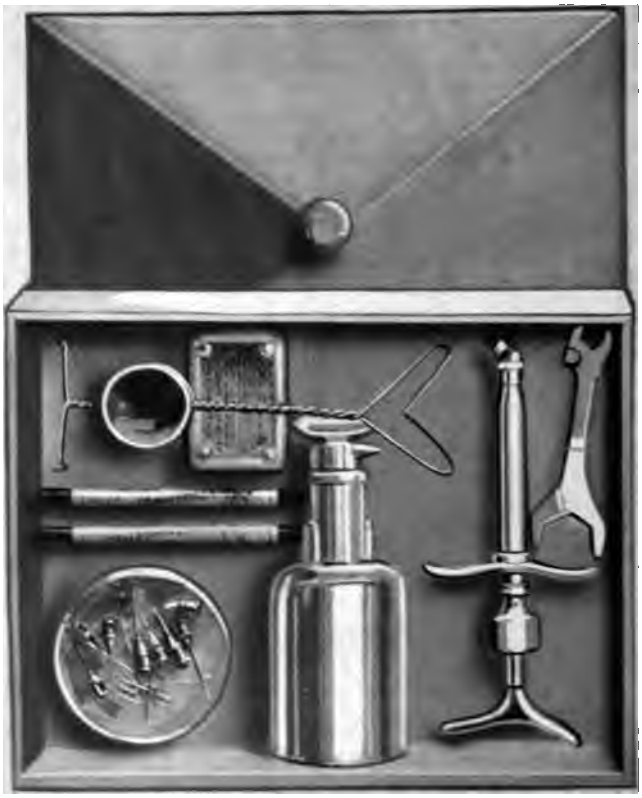


Fig. 159. Metal and glass Tag Record syringe. (2 mils.)



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Syringes Required for Efficient Work.—It is true that the operator could "get along" with one syringe, but there is no reason why he should be handicapped in any such way; he should equip himself with several good working syringes so as to be able to carry out a better technic.

The writer advises the operator to equip himself with at least four syringes similar to the following:

1. An all-glass two-mil syringe to be used for hypodermic medication in case of collapse and shock. This syringe should be equipped with a fine hypodermic needle and should be ready for use at a moment's notice, as these things are needed in case of shock and collapse, and the quicker a stimulating drug is injected, the better. However, if the operator employs the individual unit (see Figs. 583 and 584), it is not necessary to have a two-mil syringe.

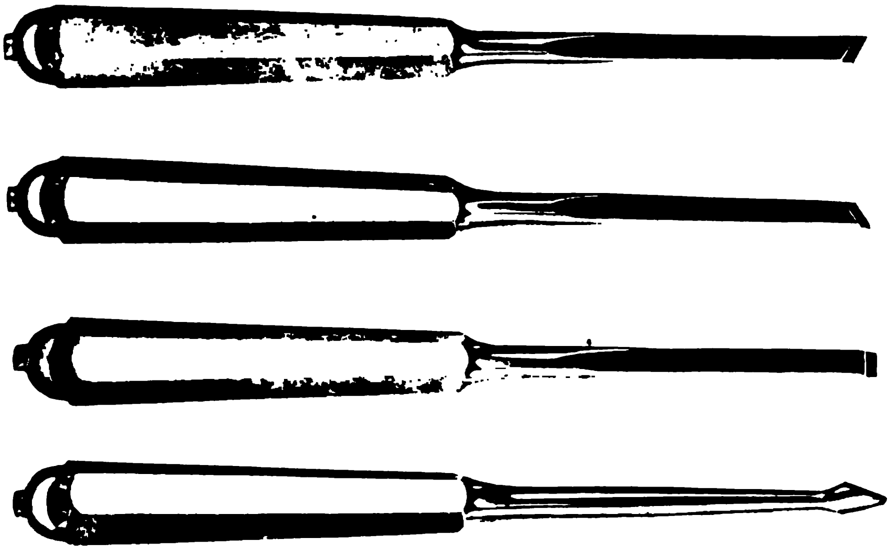

Fig. 161.—Surgical chisels. (Designed by Dr. Chalmers J. Lyons.)

2. An efficient five-mil all-glass syringe. A syringe of this size will be found of practical value in those cases requiring a large amount of solution, for such cases as blocking of the second and third divisions of the fifth nerve, Gasserian ganglion, etc. A two-mil syringe does not hold enough solution to block some of the large nerve trunks, therefore the five-mil size is preferable.

3 and 4. At least two combination glass and metal syringes, which are in good condition, should always be among the armamentarium. It is very poor practice for an operator to try to get along with one nerve blocking syringe, inasmuch as syringes are of delicate construction and liable to become broken and get out of order at any time, but when he has one in reserve, it will often save him from very embarrassing circumstances. The dentist who is taking up this work should not hesitate to equip himself with the necessary efficient appliances in order to

derive the greatest good from block anesthesia, which will be of immeasurable benefit to him and to his patients. However, the beginner should not purchase unnecessary appliances that he will never use or be of little practical value. He should use good judgment in selecting only the most efficient appliances and then keep them in the best working condition at all times.

Care of Hypodermic Syringes and Needles.—A syringe which is kept in good working order requires about as much attention and care as a watch, and the operator who disregards this will soon have a worthless syringe. A syringe is tested by placing the index finger over the tip and drawing the plunger back in order to test the grinding. The plunger should not be released suddenly, as concussion will occur and fracture the barrel. Many syringes are broken in this manner. After the syringe is used, the plunger and barrel should be separated from each other and wiped with gauze or cotton until perfectly dry, unless a sterilizing jar is used, as is strongly recommended. It is much better, after a syringe has been used for injecting an isotonic solution, which is composed of Ringer constituents, to rinse it thoroughly in sterile distilled water to remove any traces of the salts which might collect and crystallize and in time interfere with the accurate fitting of the piston. This is easily accomplished by filling the syringe several times with sterile distilled water. (See Figs. 165 and 218-*F*.) A drop of glycerin placed on the plunger will pre-

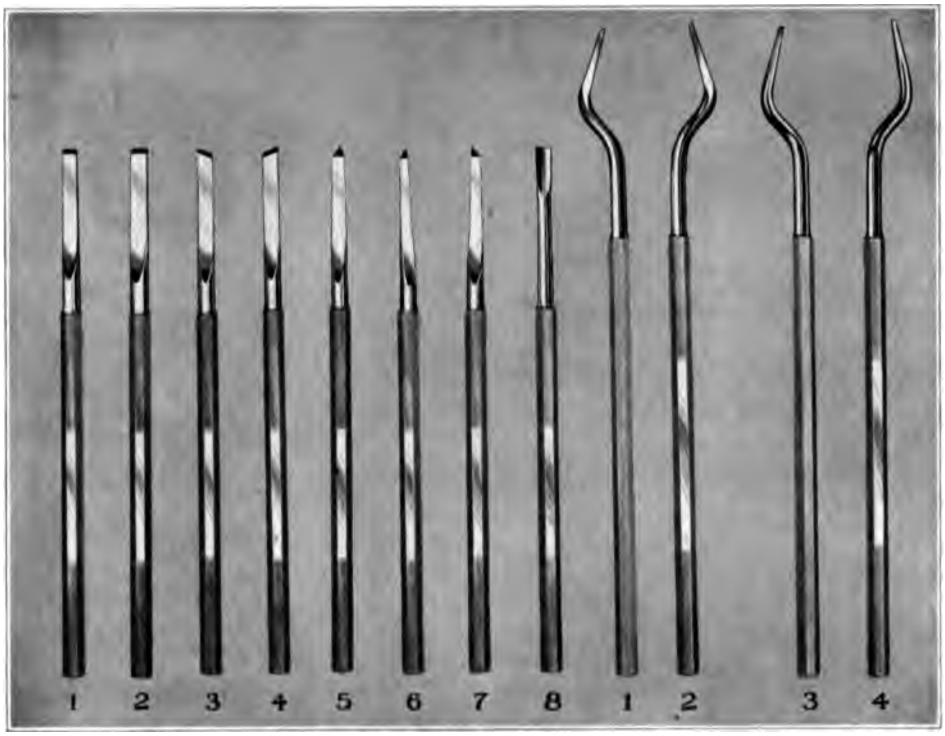

Fig. 162.—Surgical chisels. (Designed by Dr. F. F. Molt.)

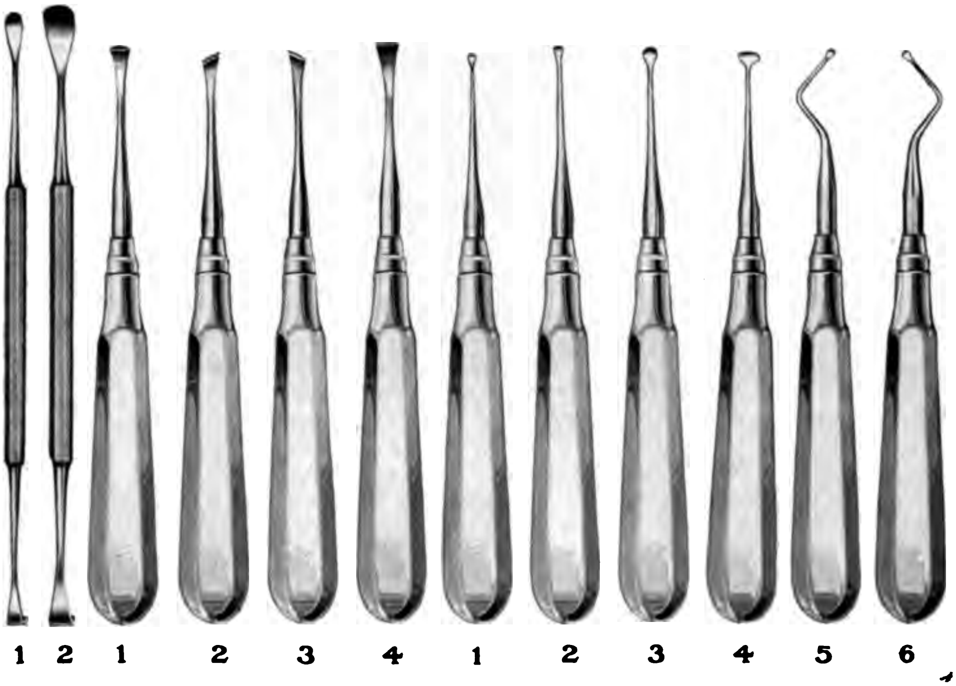

Fig. 163.—Curettes, periosteal elevators and bone scrapers. 1, 2, periosteal elevators; 1-4, bone scrapers; 1-6, curettes. (Designed by Dr. F. F. Molt.)

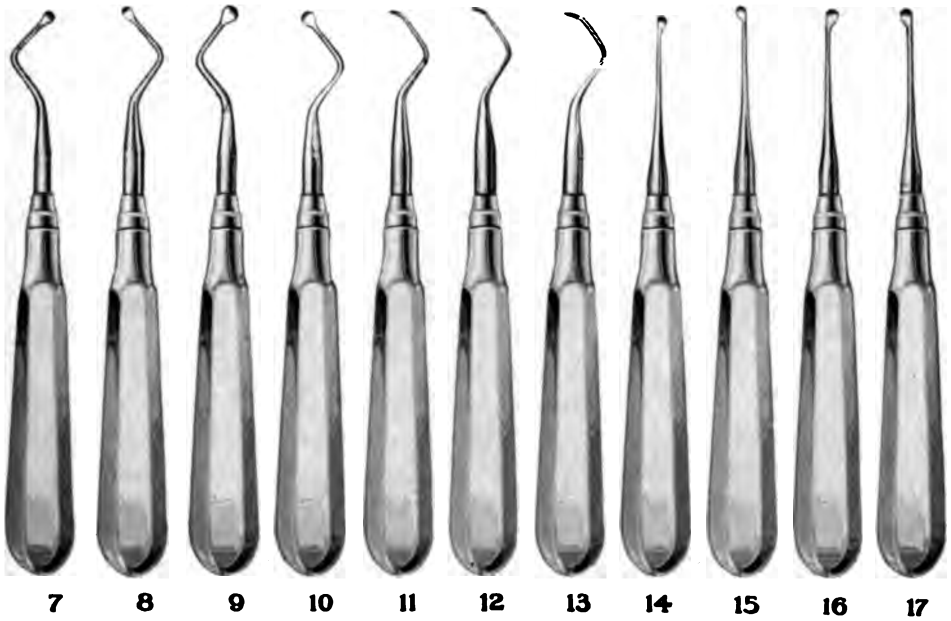

Fig. 164.—Curettes. (Designed by Dr. F. F. Molt.)

vent it from sticking and will make a better contact. The syringe is then placed in the antiseptic solution. If at any time the plunger sticks in the barrel, place the syringe in a solution containing twenty-five parts glycerin, and seventy-five parts water, gradually bringing it to the boiling point, maintaining this temperature for several minutes.

The syringes and other appliances should be allowed to remain in the antiseptic solution while not in use; this is an excellent method of sterilization, and eliminates the necessity of boiling them in water. At the time the syringe is needed, it is removed from the antiseptic solution, and the solution contained in the syringe is discharged; next, clean the syringe with sterile distilled water. (See Fig. 218-*F*.) Care should be taken not to discharge the distilled water which has been drawn into the syringe back into the receptacle; it should be discarded. This procedure should be repeated at least four or five times to make sure all traces of the antiseptic solution are removed. It should be repeated after using the syringe and before replacing it in the jar.

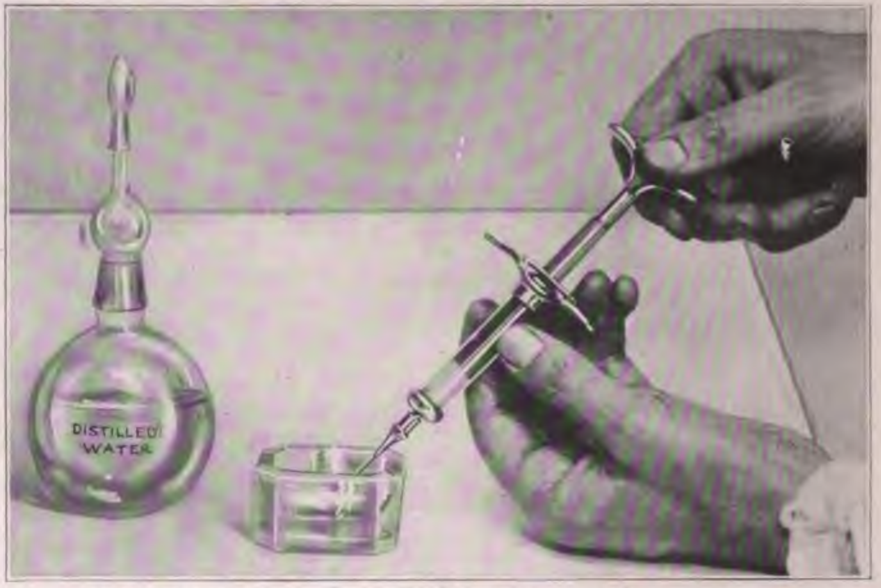

Fig. 165.—Filling the syringe with sterile distilled water to remove all traces of the antiseptic solution after being removed from the sterilizer.

After placing the proper needle on the syringe to be used for the injection, it is carried to the alcohol flame and brought to a red heat, after which it is immersed in the injecting solution, and the syringe is gradually filled. Great care should be taken not to allow the needle to come in contact with any material that is not sterile. After the tissue has been prepared at the site of injection by thoroughly drying and applying the germicide, just before the needle is inserted into the tissue, it is again placed in the flame to make sure it is sterile. Great care should be exercised not to allow the needle to come in contact with the tongue, teeth, or other structures while carrying it through the oral cavity to its proper location. Never return the needle to the injecting solution after removing it from the tissue without passing it through the flame in order to avoid contamination.

The formula of the antiseptic solution which is employed in the sterilizing jar is given below, and if this method is carefully carried out, there is no need of boiling the syringes, as the continuous boiling of syringes, especially of the metal and glass designs, produces trouble, many times causing them to leak and always subjecting them to the chances of fracture.

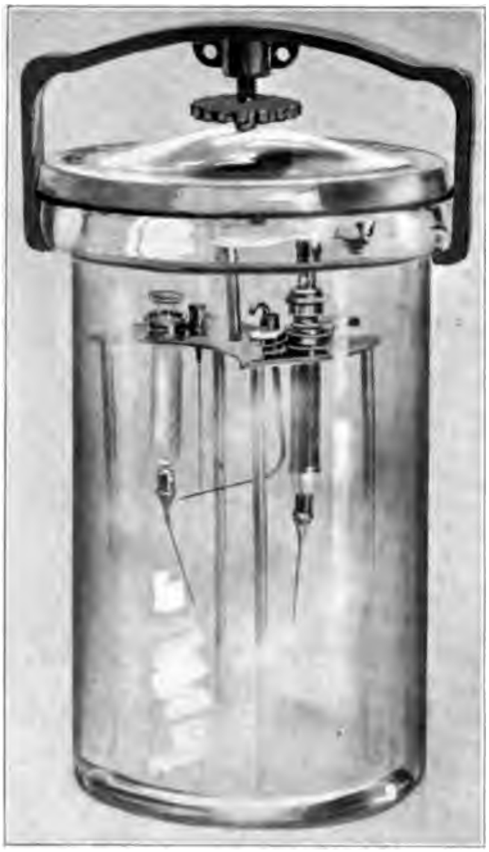

Fig. 166.—Specimen jar which may be employed as a sterilizer for armamentarium. (Suggested by Dr. Reithmuller.)

It is not necessary to boil the syringe unless it has been used upon a patient suffering from some infection, like syphilis, etc. However, if the operator thinks it is desirable to boil the syringe and not to rely on the antiseptic solution, it should always be placed in warm water and then brought gradually to the boiling point. If the operator is to use the same syringe on different patients without allowing it to remain in the antiseptic solution for a considerable length of time, it is then advisable to sterilize it by boiling. However, if a considerable length of time elapses between various patients, the syringe is returned to the antiseptic solution and is used in accordance with the technic as previously outlined. We all agree that sterilization by boiling or superheated steam is more efficient than antiseptics. On the other hand, a good antiseptic solution, to which the appliances have been subjected for a considerable length of time, is in most cases satisfactory. Syringes which have been sterilized by boiling must be allowed to cool for several minutes before they can be used. This is a drawback, as it causes the operator to lose time in waiting for the syringe to cool.

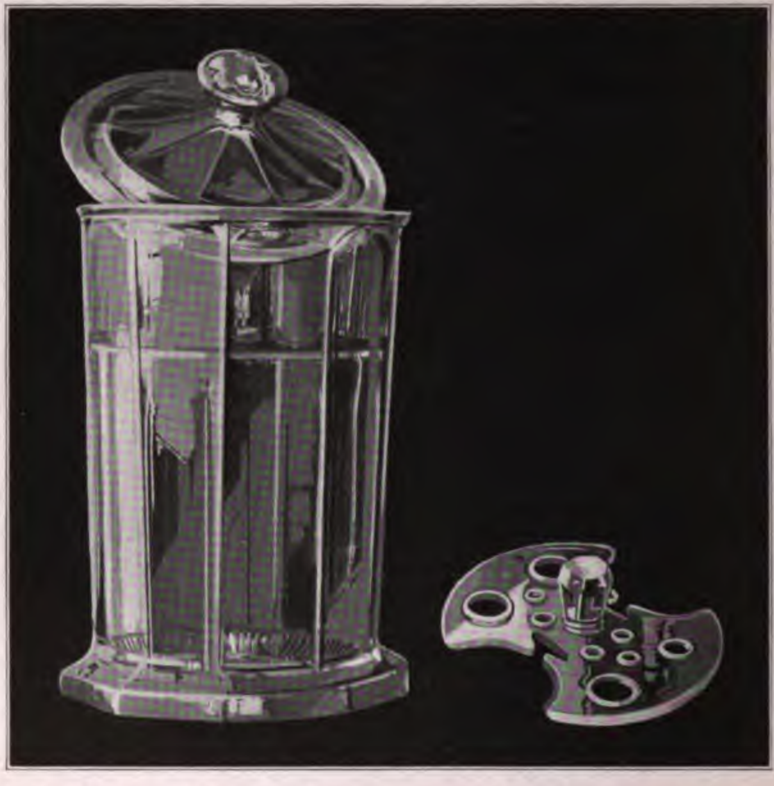

Fig. 166-*A*.—Sterilizing jar which contains glass ledge upon which rests a glass rack for suspending appliances in the antiseptic solution. (Designed by the author.)

It is advantageous and will save time to have several syringes. The first syringe, when used, can be returned to the antiseptic solution after it has been used on the first patient, and the second syringe removed from the antiseptic solution and treated, as above outlined, for the second patient, thereby doing away with the process of boiling.

The needles which are used most can be kept in position on the syringes and ready for immediate use. The other needles are kept in the rack ready for immediate use. Great care should be exercised to remove all traces of the antiseptic solution from the syringe before filling with the local anesthetic solution, as contamination may take place.

Some operators who have employed alcohol for the antiseptic solution have allowed contamination of the injecting solution. This very thing has frequently happened, and in some instances the operator has placed the blame on the anesthetic or method of block anesthesia, when, in reality, the prolonged numbness or postoperative complications have in most cases been due to the injecting of a solution contaminated with alcohol. The author does not recommend alcohol as a sterilizing medium.

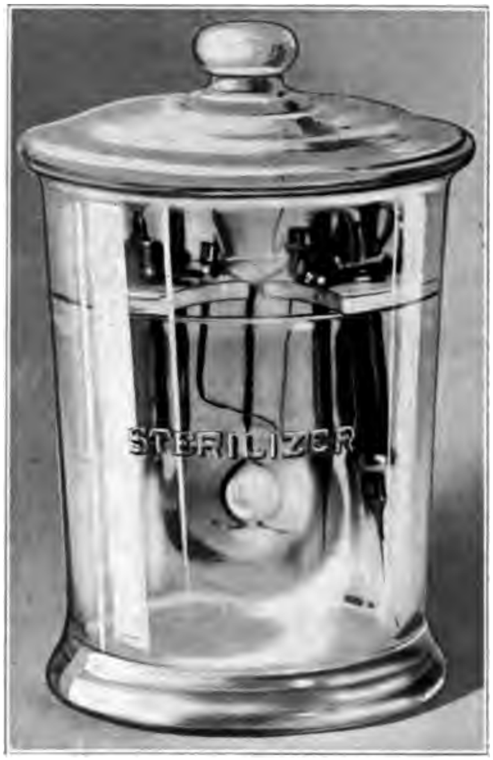

Fig. 167.—Sterilizer containing complete armamentarium. (Designed by the author.)

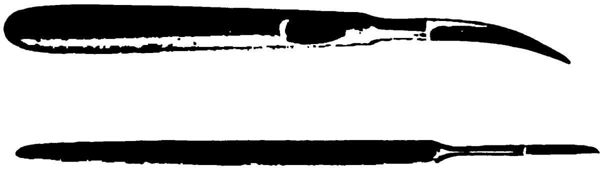

Fig. 168.—Lancets.

Hypodermic Needles.—The operator should make a careful selection of needles to be employed in the various branches of local anesthesia. The skilled operator can use one or two needles for a number of different deep nerve blocking injections, but even an experienced operator finds it to his advantage to employ the proper size and length needle in accordance with the nerves to be blocked.

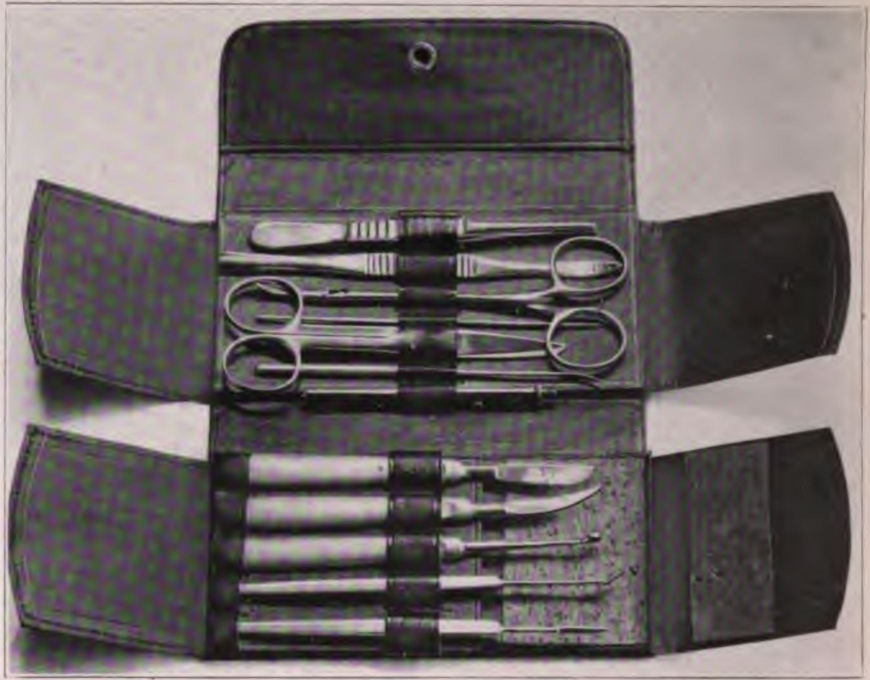

Fig. 169.—An efficient dissecting outfit for preparing wet anatomical specimens.

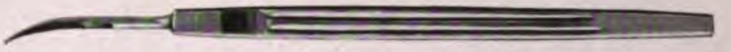

Fig. 170.—Lancet.

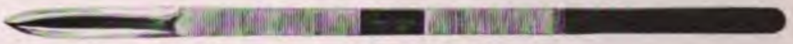

Fig. 171.—Periosteal elevator. (Designed by Dr. Jules Sarrazin.)

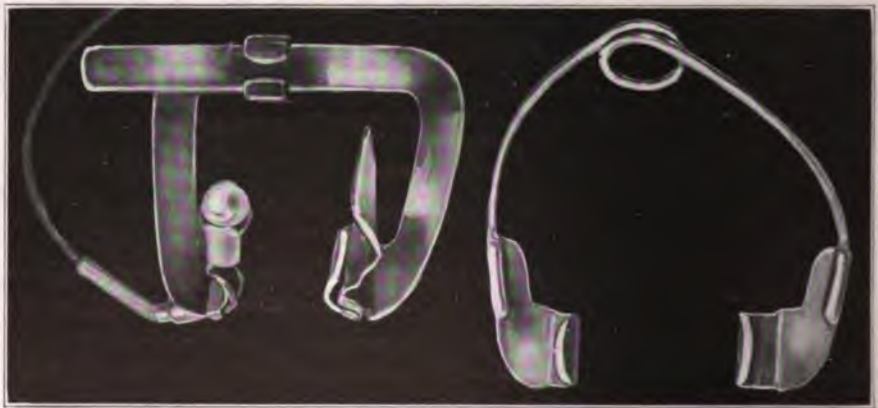

Fig. 172.—Mouth prop combined with lamp. (Designed by Cameron.)

There are five kinds of needles made of various metals, and are named here in order of their efficiency:

1. Platino-iridium.
2. Platinum.
3. Tempered gold.
4. Nickeloid.
5. Steel.

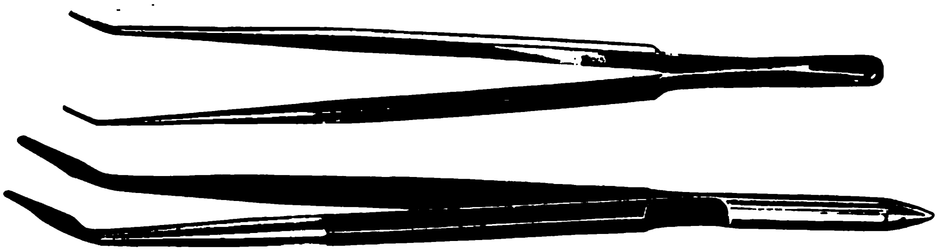

Fig. 173.—Cotton pliers.

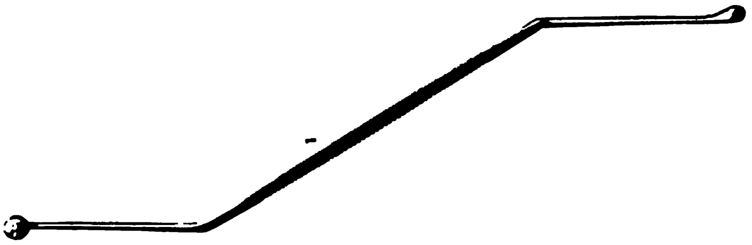

Fig. 174.—Double end curette.

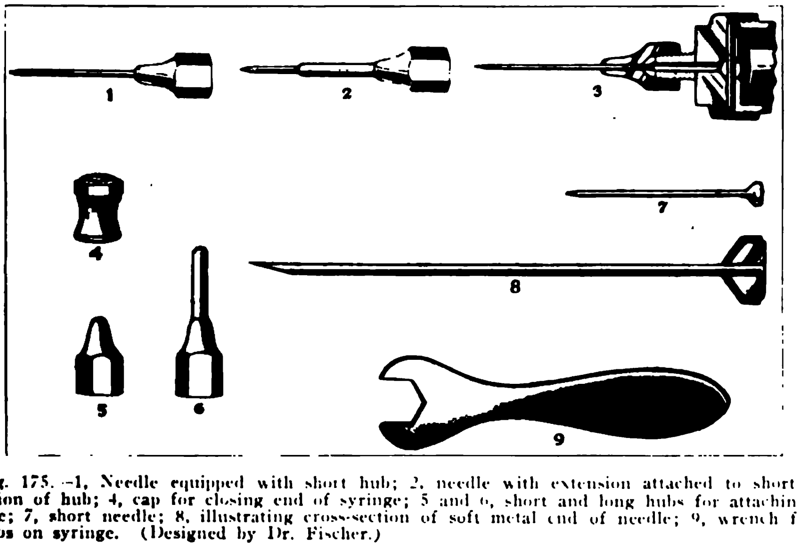

Fig. 175.—1, Needle equipped with short hub; 2, needle with extension attached to short hub; 3, cross-section of hub; 4, cap for closing end of syringe; 5 and 6, short and long hubs for attaching needle to syringe; 7, short needle; 8, illustrating cross-section of soft metal end of needle; 9, wrench for tightening hubs on syringe. (Designed by Dr. Fischer.)

Platino-Iridium Needles.—Platino-iridium needles are far superior to all others for the following reasons:

1. They can be heated in the flame for the purpose of sterilization.
2. They will not break easily.
3. They will not corrode or rust.
4. It is not necessary to keep a wire in the lumen.
5. They are more durable.
6. They are less expensive, considering their life and superiority.
7. In case they should break at the hub, they can be easily repaired for future use.

Their disadvantages are indeed few; however, the following might be mentioned:

1. They are more expensive than other forms of needles; but their increased expense should not be considered over their efficiency.

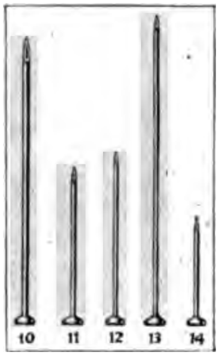

Fig. 176.—10, Needle 42 millimeters long, .9 millimeters in diameter; 11, 23 millimeter needle; 12, 26 millimeter needle; 13, needle 42 millimeters long, diameter .47 millimeters; 14, needle 16 millimeters long, diameter .42 millimeters. (Designed by Dr. Fischer.)

2. Their points become blunt somewhat easier than other forms of needles.
3. They become bent more easily.

It will be seen that any of the above disadvantages are trivial so far as efficiency is concerned.

Platinum Needles.—Needles made of pure platinum not only bend easily, but become blunt and many times the points become bent so that it is difficult to insert them into the tissue.

Pure platinum needles are much harder to break than other forms of hypodermic needles, but because of their extreme flexibility, they are not ideal for local anesthesia. Most needles required for deep nerve blocking injections are quite long, therefore if the needle does not possess a certain amount of rigidity, it is not at all suitable.

Tempered Gold Needle.—Within recent years tempered gold needles have been used, but they offer no advantage over platino-iridium. They contain a certain percentage of base metal which makes them more rigid, and the addition of this metal or metals with which the gold is alloyed, reduces the fusing point of the gold; therefore, when such needles are subjected to the flame for sterilization, they melt and are destroyed. Needles of this character will not rust or become corroded, which makes it unnecessary to insert a wire in the lumen. They will not withstand harder usage than the platino-iridium needle, in fact, they break more easily.

Nickeloid Needles.—The nickeloid needle contains nickel and other base metals. This needle is more durable and will not corrode or rust as does the steel needle. They cannot be sterilized in the flame, for such a process would take the temper out of the metal. It is better to keep small wires in the lumen after they are submerged in the antiseptic solution. They are considered by various operators to be superior to steel needles.

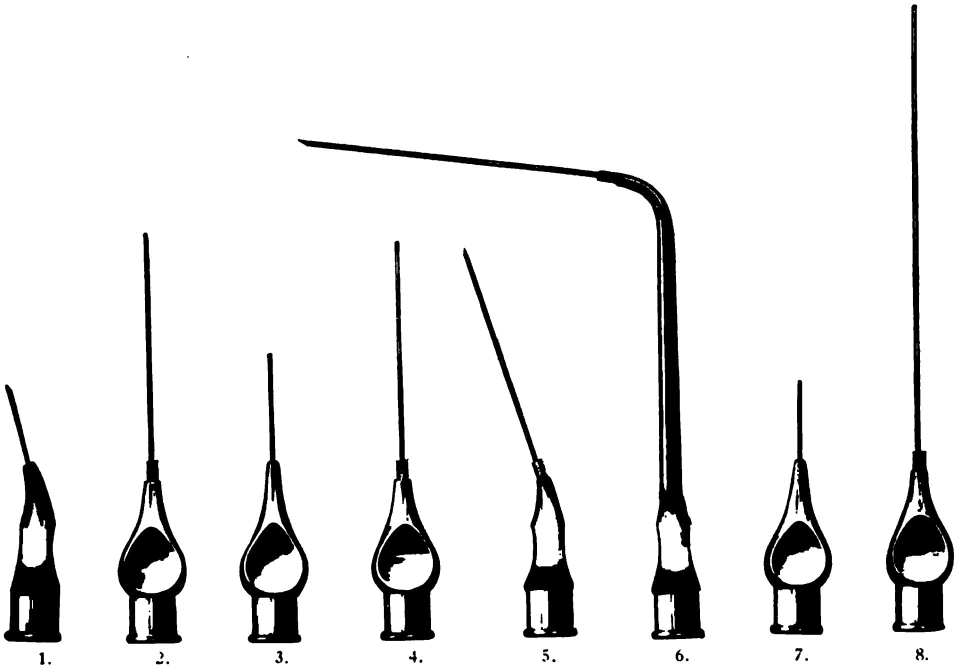

Fig. 177.—Illustrating complete set of needles for all divisions of local anesthesia, i. e., Deep nerve blocking; Intraosseous; Terminal; Infiltration methods. (Designed by the author.)

No. 1—21 ga. 10 mm.
" 2—23 ga. 30 mm.
" 3—24 ga. 15 mm.
" 4—25 ga. 30 mm.
No. 5—23 ga. 30 mm.
" 6—22 ga. 40 mm.
" 7—27 ga. 10 mm.
" 8—20 ga. 60 mm.

Steel Needles.—Steel needles do not bend easily, and while new they stand up admirably, but if used a few times, there is great danger of breakage. Many operators employ steel needles with very good results, but any one who has had a wide experience must have encountered considerable breakage, which in the long run costs about as much as well-made platino-iridium needles.

The advantages of steel needles are:

1. They are very cheap. However, this feature should not be considered. In other words, cheapness should be subordinated to efficiency.

2. They retain the proper bevel much better than other form, because of their structure.

3. They are rigid and hard to bend.

The disadvantages of steel needles are as follows:

1. They cannot be sterilized in the flame.

2. Their lumen must contain a wire when they are not in use.

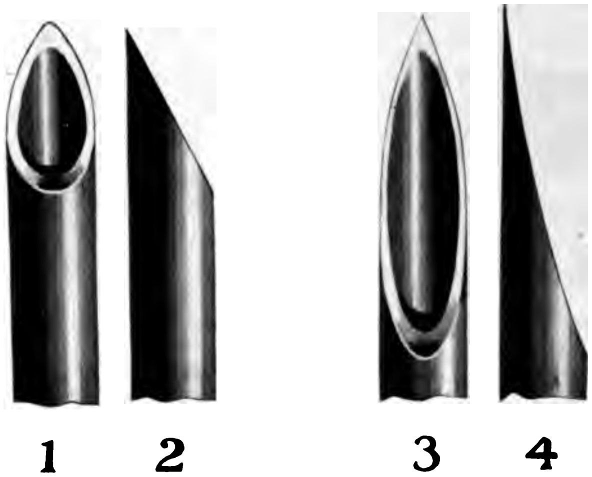

Fig. 178.—Illustrating the correct and incorrect methods of sharpening needles for deep block injections. 1 and 2 shows the needle with a sharp short bevel, which is the correct way; 3 and 4 shows the needle with a long bevel and pointed, which is incorrect.

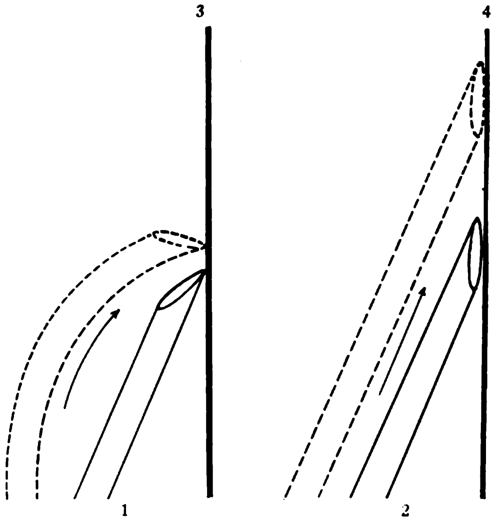

Fig. 179.—Illustrating the correct and incorrect methods of inserting the needles for deep injections. The bevel of the needle should be towards the periosteum. 1, Incorrect method; 2, Correct method; 3 and 4 represent periosteum. (After Seidel.)

3. They break at the hub very easily, especially after they have been in use.

4. They corrode and rust easily.

5. Their lumen becomes easily clogged.

6. They should be used only a few times and discarded.

7. It may be impossible for the sterilizing solution to always reach the bacteria located in their lumen.

8. They cannot be sterilized as quickly as those made of platino-iridium.

The writer recommends platino-iridium needles for block anesthesia over all other forms. Steel needles, or the other forms, it is true, can be used for infiltration, submucous, peridental or subperiosteal methods of anesthesia, because if they become broken at these superficial points they can be easily removed from the tissue, whereas if they are broken off while making a deep nerve blocking injection, many times it is very difficult to remove them. A very fine platino-iridium needle is admirably adapted for injecting the first few minims of the anesthetizing solution into the tissue which is hypersensitive, such as the region of the naso-palatine nerves as they emerge through the hard palate; or preceding the use of the intraosseous lancet and retractor. It is very difficult to keep the lumen of a small steel needle open, while a small platino-iridium needle can be heated in the flame, which opens the lumen. Platino-iridium needles should contain 80 per cent platinum and 20 per cent iridium.

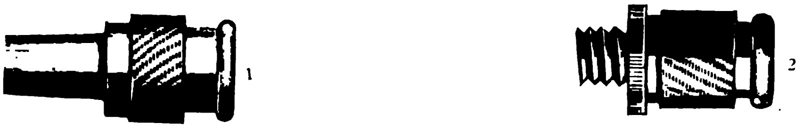

Fig. 180. Attachments for various needles. 1, Thread to slip; 2, slip to thread. (Designed by the author.)

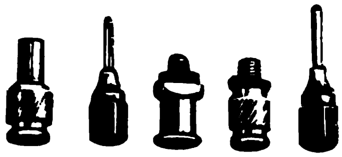

Fig. 181.—Adapters and hubs for attaching needles to various syringes.

The Attached and Detachable Needle Hub.—A needle which is permanently attached to the needle hub has the following advantages:

1. It is easily changed.

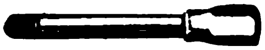

Fig. 182. Extension hub. (Designed by Dr. Fischer.)

2. The ground needle hub fits over the ground cone-shaped syringe tip.

3. Threads and washers are eliminated.

4. They are more sanitary.

5. If necessary, they can be detached from the syringe tip, leaving the needle in position in the tissue while the syringe is refilled with the anesthetizing solution.

6. When the hub and tip are accurately ground, the needle will not come off during an injection and will not leak at the joint.

The detachable needle and hub, such as the Schimmel design, are very efficient; however, the hub screws on the tip of the syringe, and is not as clean or as easily changed as the "slip-on" hub. The Schimmel needle is free from leather washers, which is an admirable feature, the contact being made between the extreme tip of the syringe and needle by means of a soft metal which is attached to the needle.

Care of Needles.—The operator should always keep his needles in the best working condition, and should see that they have the proper bevel. (See Fig. 178.) An Arkansas stone about the size of a ten cent piece, mounted on a mandrel, is admirably adapted for placing the proper bevel on the needles. (See Figs. 183 and 200.) Needles should be kept in the sterilization jar in the rack or placed in a small glass tube which is held by the rack, and submerged in the antiseptic solution along with the other block anesthesia appliances. At the time of injection the proper syringe and needle are taken from the antiseptic solution, and treated in the manner already described under the heading "Care of the Hypodermic Syringes and Needles," page 296. Caution should be exercised to remove all traces of the antiseptic solution, and before the needle is placed in the anesthetizing solution it should always be passed through the flame (provided an

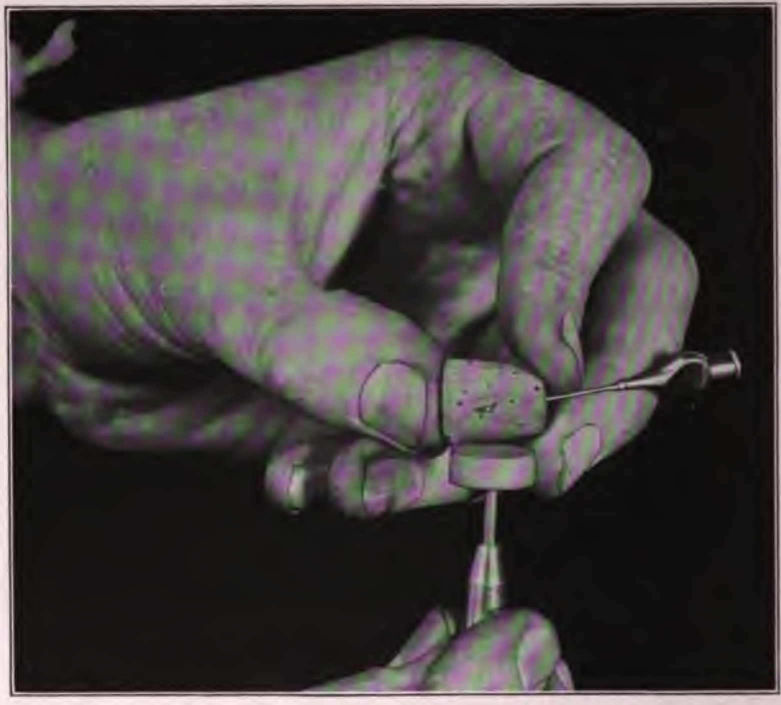

Fig. 183.—Illustrating the method for sharpening the needles for deep block anesthesia. The needle is inserted through the cork as illustrated. This is a convenient method of holding the needle in order to bevel it properly with the stone which is 1½ centimeters in diameter. (Suggested by the author.)

iridio-platinum needle is employed) in order to make sure that the lumen is open and is absolutely sterile.

An efficient method for quick sterilization of the other needles which are not composed of iridio-platinum is to place them in a test tube containing water and boil for several minutes. However, if they have remained in the antiseptic solution, the boiling process is not necessary. (See Fig. 185.)

For high pressure anesthesia, Dr. Prinz has suggested the use of a needle hub. An ordinary Luer steel needle is employed. The needle is ground off at the hub, and the extension is pointed.

In selecting needles for block anesthesia it should always be borne in mind that they should be of sufficient length and diameter. Needles from 23 to 25 gauge are ideal for practically all deep nerve blocking injections. However, for the blocking of the second division by the intraoral method, or the blocking of the second and third divisions by the extraoral method, or the Gasserian ganglion, the needles should be of greater diameter. Fig. 177 shows a set of eight needles which are adapted to all forms of block anesthesia. The standard Luer ground hub has been employed with a longer and flattened extension, so that it is more convenient for the operator to make the injections in the posterior portion of the oral cavity. This extension eliminates the insertion of the end of the barrel of the syringe into the patient's mouth in order to insert the needle the proper distance. The needle is permanently attached to the hub, and the hub is gold plated.

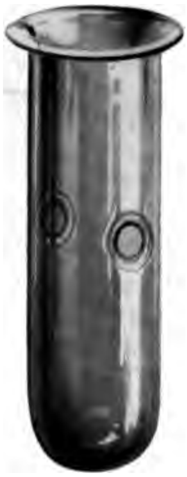

Fig. 184.—Small receptacle which is used to suspend surgical burs, needles, broaches, drills, etc., in the antiseptic solution and is held by the porcelain rack. (Designed by the author.)

Should the needle break at the hub, which is the weakest point, the needle guard will pull it out of the tissue, due to the guard gripping the needle. In case no guard is employed, the operator should make it an ironclad rule never to insert a needle up to the hub, but always use a needle so long that, at least, one centimeter will remain exposed, after the nerve to be blocked is reached. In case it is broken, little difficulty will be encountered in removing it.

The reader, at first, may get the impression that a set of eight needles, as suggested by the author, are entirely too many, but before passing judgment he should consider the large number of injections and the various methods of local anesthesia. The eight needles include the preliminary needle, the special needle for blocking the second division of the fifth nerve by the intraoral method, blocking of the second and third divisions of the fifth nerve by the extraoral method, tonsil blocking for tonsillectomy, blocking of the Gasserian ganglion, infiltration or terminal method, intraosseous method, and the many deep block injections which are made within the mouth.

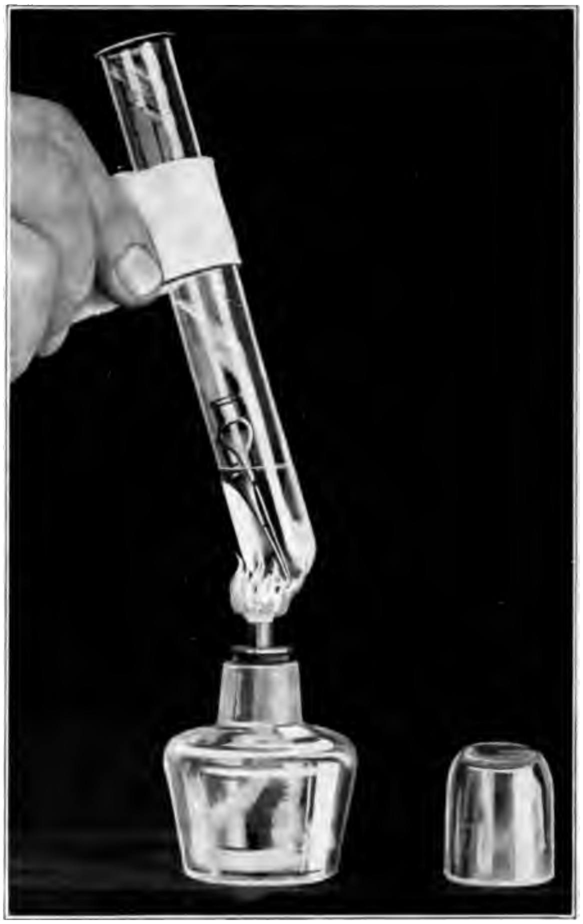

Fig. 185.—Illustrating a rapid, efficient method of sterilizing a needle with distilled water in test tube.

Safety Needle Guard.—There is always a possibility of breaking a needle while making a deep injection, even if a platino-iridium needle is employed.

Some dentists hesitate to make deep injections for fear the needle will break or some accident will happen. An accident may occur, but if all technical points are observed, little or no trouble should be encountered. Block anesthesia requires a definite technic in order to secure the best results, just the same as cavity preparation, inlay technic, taking impressions, etc. There is some danger connected with almost any branch of dentistry or oral surgery, but these possibilities should, by no means, prevent an operator from enjoying the advantages afforded him through the medium of the various methods of local anesthesia.

For the deep injections, a guide of some character on the needle is advantageous to the operator while inserting the needle. Braun suggests a small piece of cork or rubber to be slipped over the needle to indicate a certain distance. This temporary guide can be removed to suit the requirements of the case, the cork being placed on the needle at a measured point. The breaking of needles seems to be on the minds of many operators, especially those who are just entering the field of block anesthesia. The writer has given this subject considerable thought in trying to evolve some efficient device, which would prevent the needle from being inserted too far and to facilitate its removal, if broken. Take, for example, the three centimeter needle used for blocking the inferior dental and lingual nerves. The average distance the needle is inserted to block the inferior dental nerve is two centimeters, and when in position, one centimeter, which is covered by the guard, remains outside the tissue. The needle guard, which is a coil spring (see Fig. 186) is a fraction smaller than the needle and covers one centimeter of the needle; it being attached to the needle hub by means of threads.

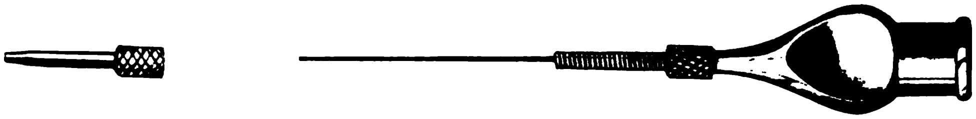

Fig. 186.—Needle guard which strengthens the needle at the soldered joint and prevents the needle from being inserted too far into the tissue. If the needle is broken at the joint during the process of injection the gripping action of the coil spring will remove the broken fragments from the tissue. (Designed by the author.)

The advantages of a needle guard are as follows:

1. It is impossible to insert the needle into the tissue farther than the end of the spiral coil. If the needle should break at the hub, the spiral coil will pull the needle out of the tissue by its gripping action.

2. The joint between the hub and needle is reinforced by the coil spring, yet it allows lateral flexibility of the needle.

Still.—The necessity of employing sterile distilled water has been discussed in Chapters XIX and XX. Some operators purchase their distilled water from a druggist, but unless there is certainty of its purity it is not to be recommended. Many times the druggist obtains distilled water from local concerns who obtain it from an ice plant or laundry. If this is the case, chemical purity is not assured, and, inasmuch as every precaution should be taken in the preparation of

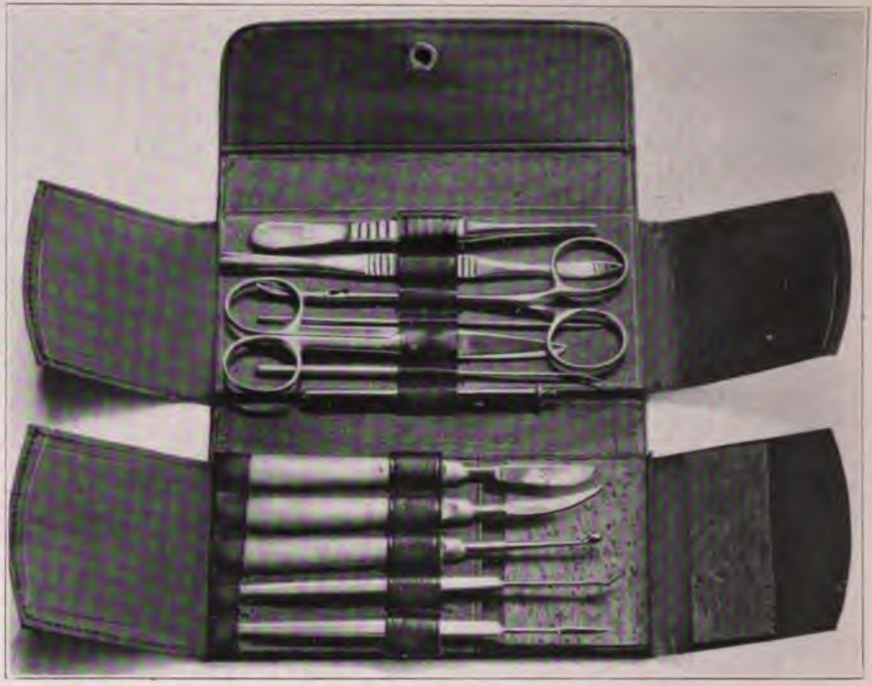

Fig. 169.—An efficient dissecting outfit for preparing wet anatomical specimens.

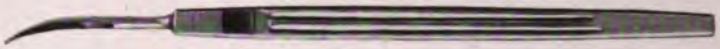

Fig. 170.—Lancet.

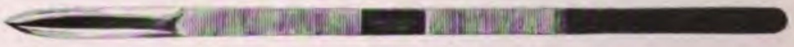

Fig. 171.—Periosteal elevator. (Designed by Dr. Jules Sarrazin.)

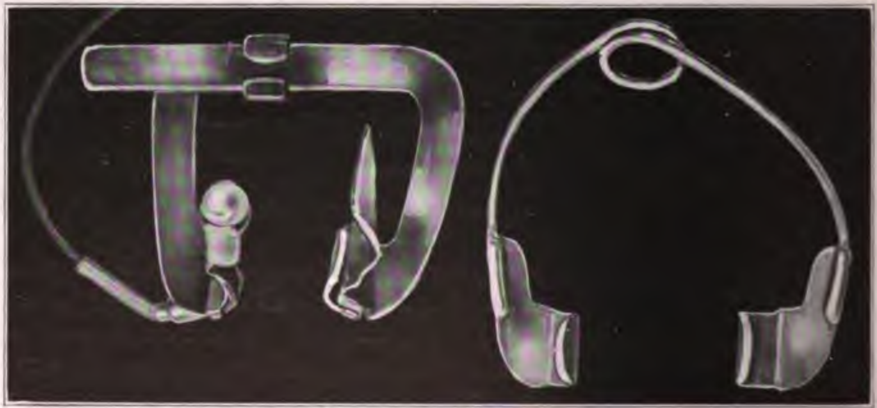

Fig. 172.—Mouth prop combined with lamp. (Designed by Cameron.)

There are five kinds of needles made of various metals, and are named here in order of their efficiency:

1. Platino-iridium.
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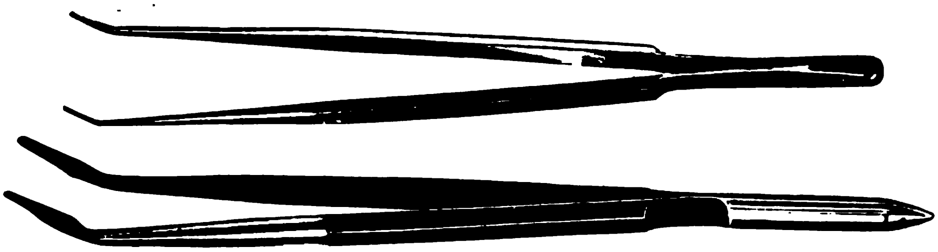


Fig. 173.—Cotton pliers.

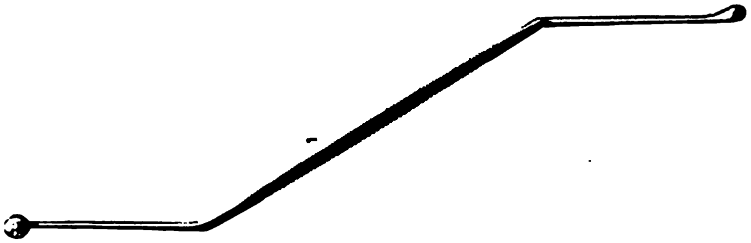


Fig. 174.—Double end curette.

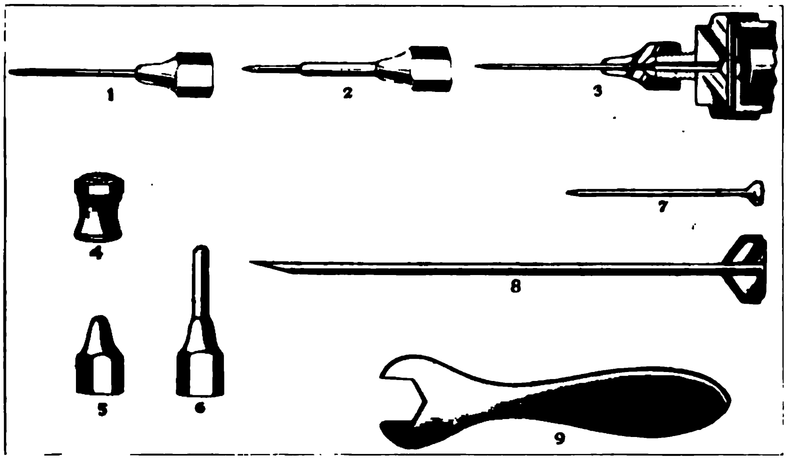


Fig. 175.—1, Needle equipped with short hub; 2, needle with extension attached to short hub; 3, cross-section of hub; 4, cap for closing end of syringe; 5 and 6, short and long hubs for attaching needle to syringe; 7, short needle; 8, illustrating cross-section of soft metal end of needle; 9, wrench for tightening hubs on syringe. (Designed by Dr. Fischer.)

the point indicated by "X," which indicates the level of the water in boiler No. 2. The opening in the overflow tube should be four or five times greater than that of the intake tube so the water will not overflow, but retain the level indicated by "X." No. 8 represents a tube which is one centimeter in diameter which connects boiler No. 2 with cooling chamber No. 1. No. 9 is a glass or block tin coil which connects the boiler with the cooling chamber and extends through the bottom of the cooling chamber to receiving glass No. 10. If glass is employed, contact is made by means of a rubber cork. The arch and coil should

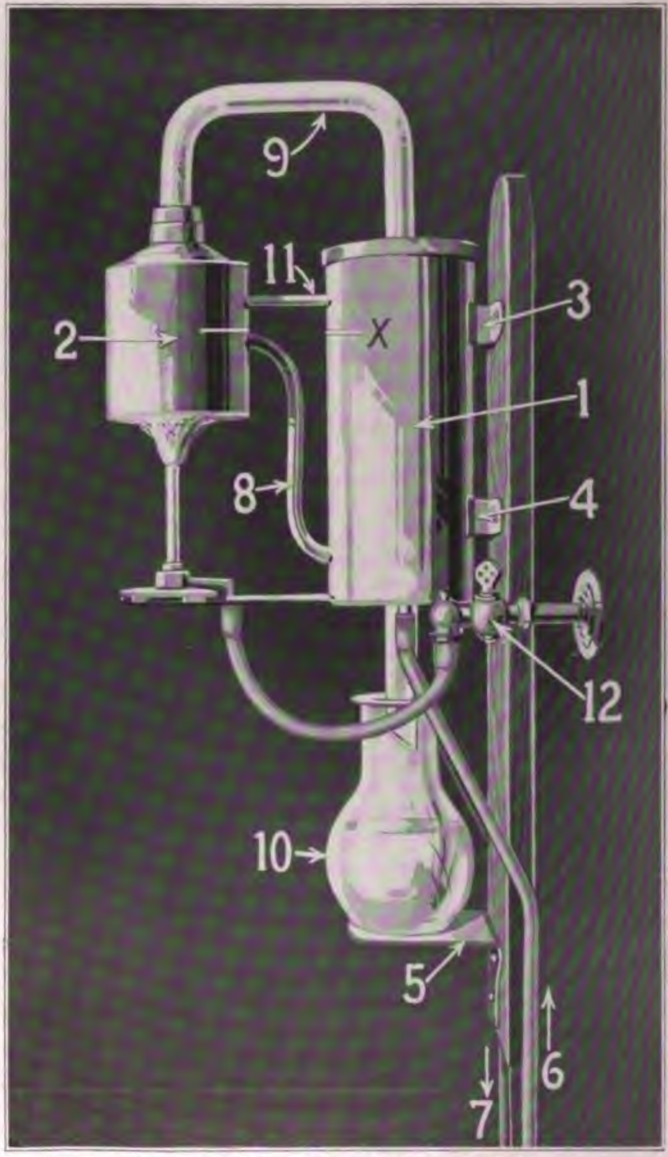


Fig. 189.—Still. (Designed by the author.)

be at least one-half inch in diameter, as a smaller lumen offers resistance to the steam when passing through it, and back pressure prevents the water from flowing into boiler No. 1. A half inch tube offers practically no resistance and does not interfere with the automatic flow. If block tin is employed a series of tubes are used inside of No. 1 instead of a coil because a 1/2 inch metal tube is difficult to coil. The water is now turned on through the inlet tube No. 6 and gradually descends until it reaches the level of the outflow tube No. 7, and as the water ascends in the cooling chamber No. 1, it also ascends in tube No. 8, which connects with Boiler No. 2, and it assumes the same level in the boiler as in the cooling chamber. The Bunsen burner is soldered to the extension which is utilized as the bottom of the cooling chamber. Within a few moments after the Bunsen burner is lighted, the steam will condense in cooling chamber No. 1, and pass out as distilled water into flask No. 10. As the surface of the water is lowered in the boiler, due to evaporation, the water flows in through the connecting tube, therefore the height of the water in No. 1 and No. 2 is always the same. It needs no attention whatsoever while in operation. Instead of employing rubber for the intake and outflow tubes, small flexible metal tubing can be employed attaching the same to the still by means of solder.

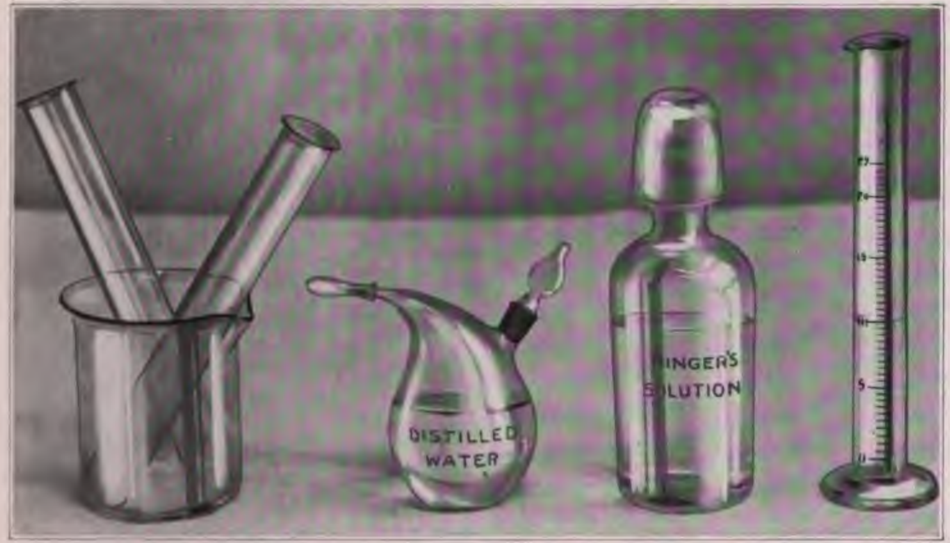


Fig. 190.—Useful accessories for the preparation of injecting solutions.

Block tin will not break and is therefore more durable. Steam which has been condensed in block tin tubes produces distilled water which is in every way efficient. Some operators are under the impression that block tin should not be used, and the writer desires to state that he has discussed this question with Professor C. A. Cary, chemist, who has conducted considerable research in the laboratories of the University of Chicago, and he makes the following statement: "In my opinion a block tin coil is highly efficient, and many gallons of distilled water which has been condensed in a block tin coil would have to be evaporated in order to obtain a positive test for tin."

Many delicate chemical tests are made with distilled water which has been condensed in a tube of this nature, so the erroneous idea that distilled water should not be employed, unless condensed in a glass coil, is in need of correction.

It is an easy matter to prepare a small quantity of distilled water daily, which is to be recommended rather than to keep on hand a stock solution for an indefinite period.

Flask for Distilled Water.—It is essential to keep distilled water in a flask of alkaline-free glass. Figs. 190, 191, and 192 illustrate flasks which are adapted to this purpose. Ordinary glass contains alkali which may contaminate the distilled water, and such contamination should be avoided because adrenalin or synthetic suprarenin are very sensitive to alkalies. One minim of dilute hydrochloric acid can be added to 300 mils of distilled water in case a stock solution is desired; however, this is not to be recommended over the distilling of the water daily.

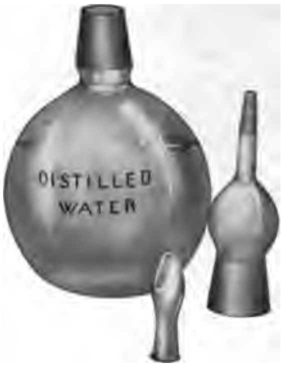


Fig. 191.—Distilled water container with accurately fitted ground cover and cap.

Container for Ringer Solution.—If a stock Ringer solution is to be employed, a flask similar to that for distilled water can be used, and the same requirements are necessary here as those already given.

Glass Graduate.—A 15-mil glass graduate is a convenient and useful accessory. An accurate amount of the vehicle can be measured, in case a considerable quantity of the anesthetizing solution is to be made. (See Fig. 192.)

Anesthetic Tablet Dissolving Cups.—Anesthetic dissolving cups made of porcelain are convenient and useful in preparing the injecting solution. The three- and ten-mil sizes are ideal. In case a small amount of the solution is desired, the three-mil cup is employed, while, with a larger amount, the ten-mil cup is used. The cups are held by means of handles which are made of nickel-plated twisted wire. *It has been found that the porcelain cups are often inaccurately graduated, in fact, there may be a variation of from 1 to 6 mils.* Such inaccuracy in graduation should not be tolerated because it is impossible to prepare an isotonic Ringer vehicle. The writer employs an accurately graduated pipette which is shown in Fig. 218-*F*.

Anesthetic Cup Dissolving Stand with Alcohol Lamp.—An anesthestic cup dissolving stand with alcohol lamp is convenient for holding the three- or ten-mil receptacle during the process of boiling the distilled water. (See Fig. 195.)

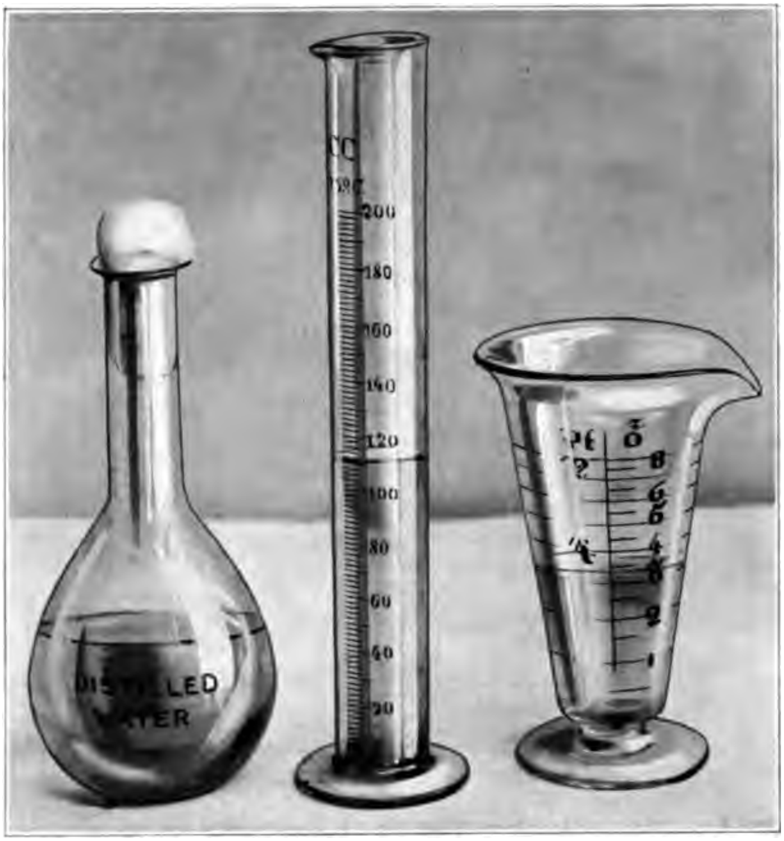


Fig. 192.—Flask with cotton stopper which may be employed for distilled water. The graduates are used for measuring a large quantity of solution.

Fig. 193.—Chemical porcelain receptacle which may be employed for preparing a large quantity of injecting solution.

Test Tubes.—Test tubes are very convenient to have among the armamentarium. They may be used for sterilizing needles or other small appliances by means of boiling; also for retaining sterile distilled water for cleaning the syringe after it is removed from the antiseptic solution.

Sterilizing Jar.—A sterilizing jar of sufficient size is employed for keeping the block anesthesia appliance sterile and ready for immediate use. (See

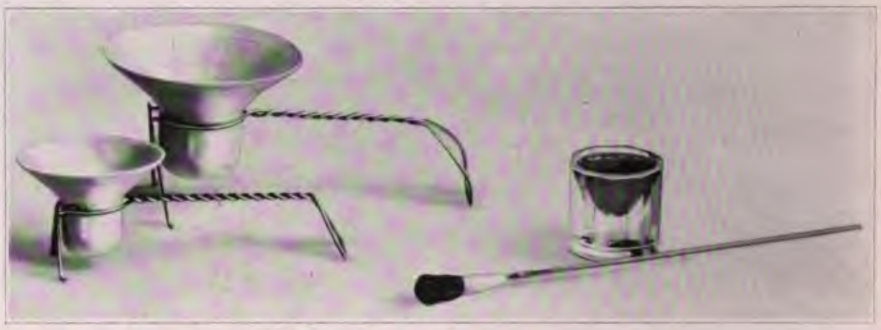


Fig. 194.—Illustrating the 3 and 10 mil local anesthetic dissolving cups, also iodin receptacle and applicator.

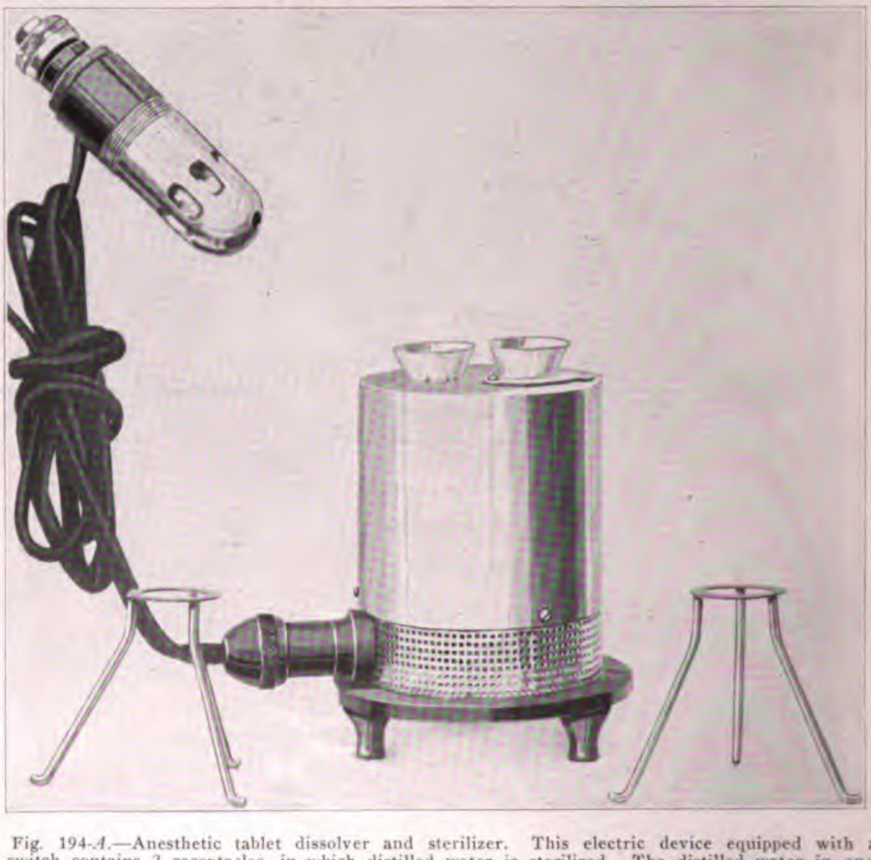


Fig. 194-*A*.—Anesthetic tablet dissolver and sterilizer. This electric device equipped with automatic switch contains 2 receptacles, in which distilled water is sterilized. The distilled water in one receptacle is used for cleaning the syringe and needle after being removed from the antiseptic solution in sterilizing jar. The other receptacle is accurately graduated and holds 10 mils which is employed for preparing the injecting solution. (Designed by the author.)

Figs. 166-A, 197 and 198.) The lid and top of the jar are ground to fit each other, to prevent evaporation of the antiseptic solution and to keep out dust and other debris. One of these sterilizing jars contains a metal stand, while the other contains a porcelain rack for the purpose of suspending the various appliances in the antiseptic solution.

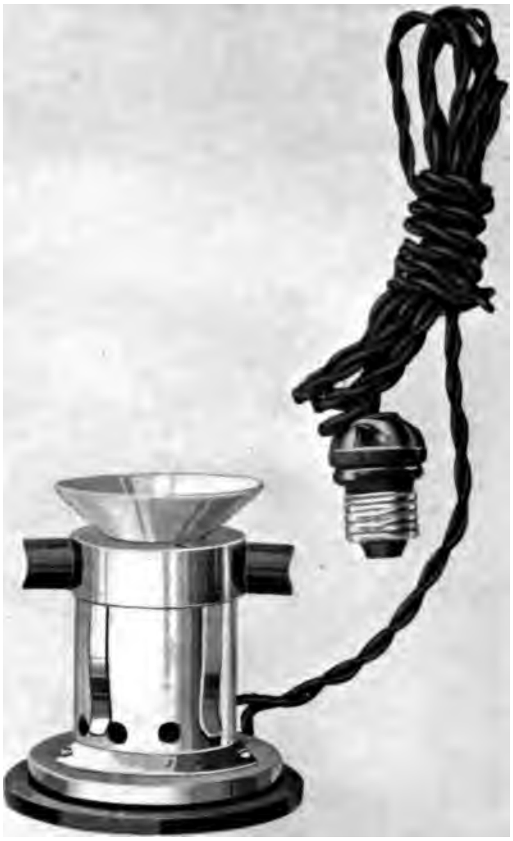


Fig. 194-*B*.—Anesthetic tablet dissolver for preparing the injecting solution using 10 mil porcelain cup. Device is equipped with automatic electric switch. (Designed by the author.)

The following appliances should be suspended in the solution and ready for immediate use:

1— 2-mil syringe for hypodermic medication.
1— 5-mil glass syringe for certain deep block injections.
2— 2-mil combination metal glass syringes for block injections.
3 artery forceps.
1 surgical scissors.
1 lancet.
1 cotton pliers.
1 intraosseous outfit.
Bone burs, broaches, and extra needles.

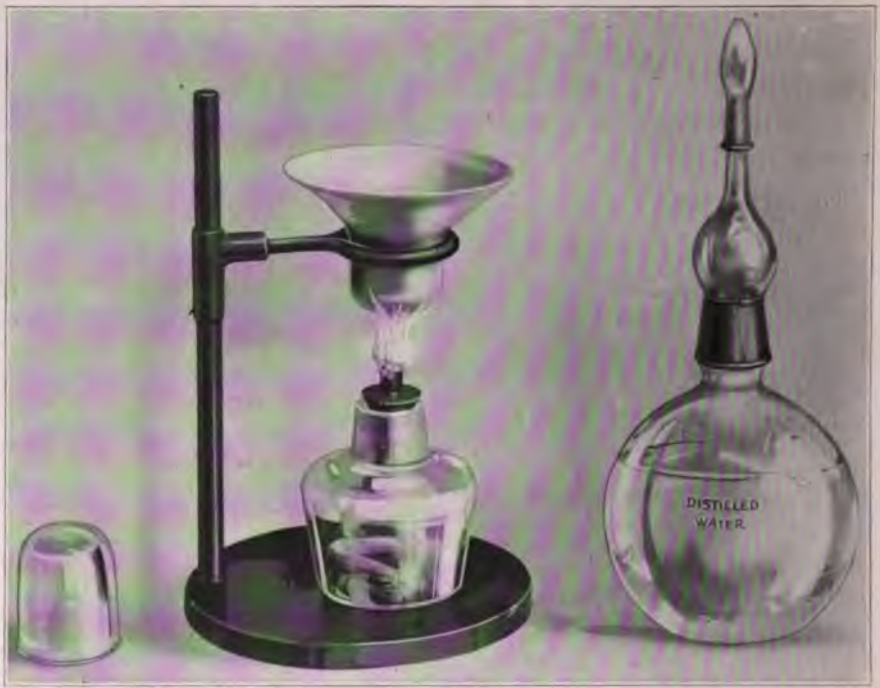


Fig. 195.—Adjustable metal stand for retaining the dissolving cups during preparation of the injecting solution.

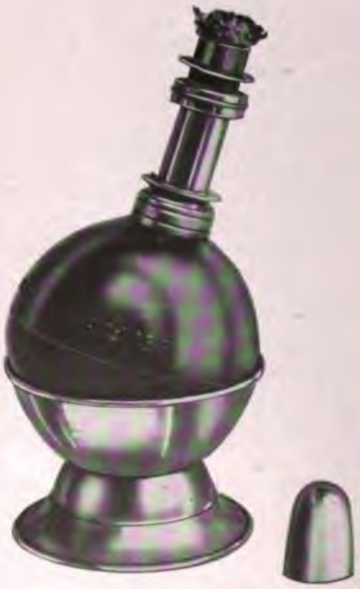


Fig. 196.—Jeweler's lamp which is a convenient appliance for quickly sterilizing the local anesthetic vehicle.

The Sterilizing Solution.—An efficient antiseptic solution is placed in the sterilizing jar for keeping the instruments in a sterile condition and ready for immediate use. The sterilizing jar should contain about one and a half liters (1500 c.c.) of the solution, as this amount will extend near the rack which holds the appliances. An antiseptic solution composed of 70 parts of alcohol and 30 parts glycerine has been employed considerably as a sterilizing medium. The addition of glycerin to the alcohol will keep the

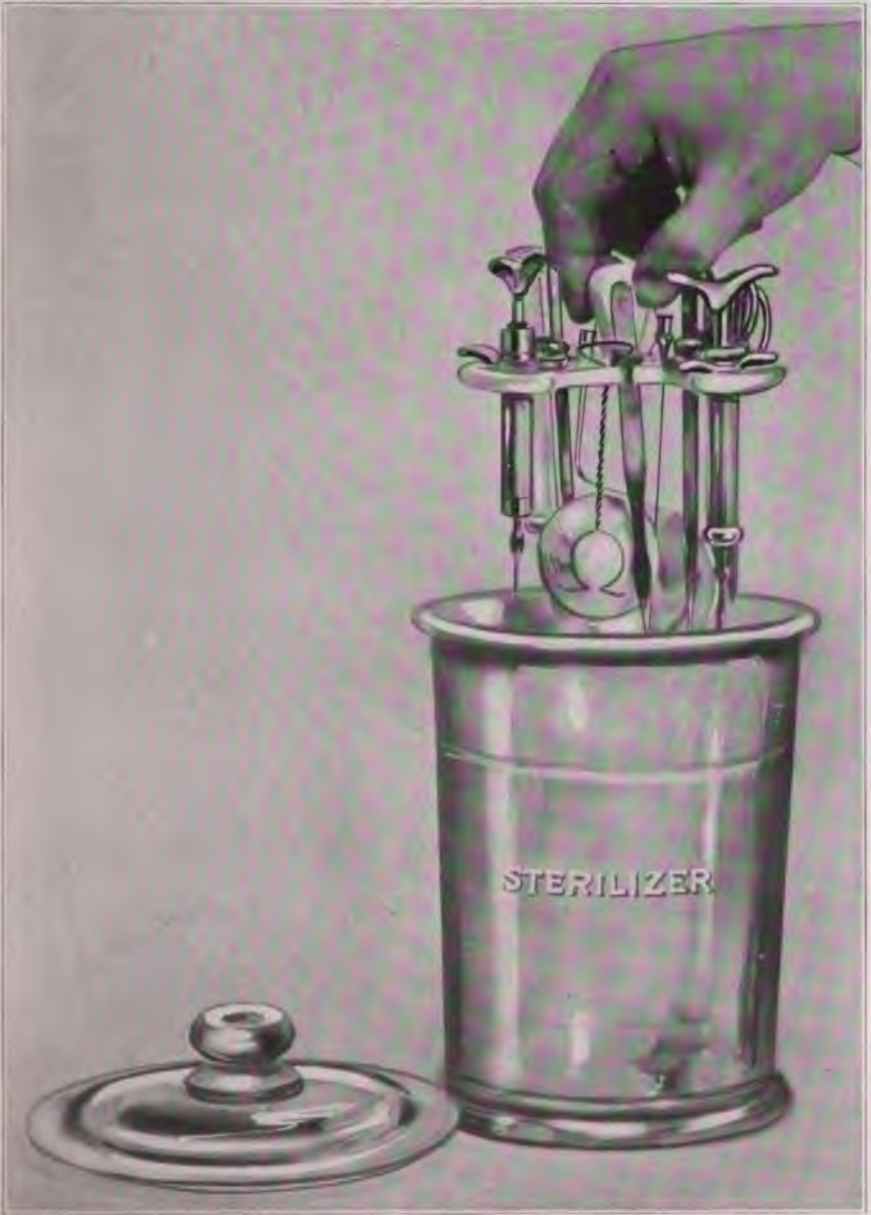


Fig. 197.—Sterilizer which contains antiseptic solution into which the block anesthesia armamentarium is suspended by a porcelain rack.

syringes in better working condition. This solution is rapidly passing into disfavor because a number of cases injected have resulted in prolonged or partial anesthesia of the parts blocked due to contamination of the anesthetizing solution.

The alcohol-glycerin solution has the following disadvantages:

1. It is not an efficient germicide.
2. If any of the solution is retained in the syringe and is injected with the anesthetic, a numbness or partial prolonged anesthesia may result.

There is no question but that block anesthesia has been wrongly condemned in some cases in which anesthesia or prolonged numbness of the part followed the operation. No doubt many times the assistant or even the operator himself has not used due diligence in removing every trace of the alcoholic solution from the plunger and barrel of the syringe, before the anesthetizing solution was drawn into the syringe. If alcohol is employed as an antiseptic solution, every trace should be removed by cleaning the plunger and barrel in sterile distilled water. An inexpensive and convenient antiseptic which answers all practical purposes is the following:

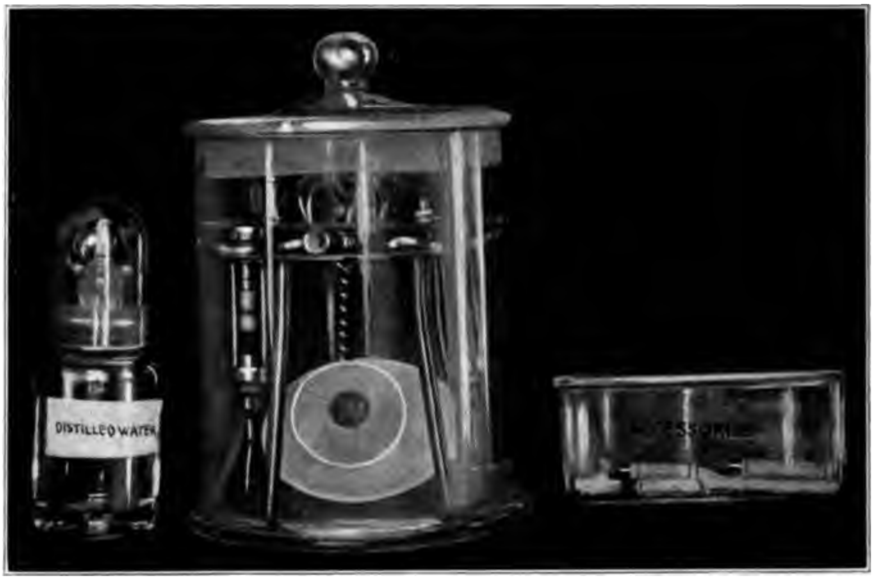


Fig. 198.—Sterilizer containing metal stand for retaining appliances in antiseptic solution. (Designed by Dr. Thoma.)

		Gm. or Mil
℞	Phenol (C.P.)	20
	Sodium biborate	5
	Glycerin	200
	Peppermint water	30
	Distilled water q.s. ad	1500
	Misce.	

Sig.: Use in sterilizing jar *as antiseptic.*

NOTE: Upon standing this solution will assume a pinkish color due to the phenol. However, the change in color does not reduce its antiseptic qualities.

Tray for Reserve Tablets, Needles, Etc.—A small porcelain or glass tray is convenient for retaining reserve needles, tablets and other accessories. The tablets should be protected from air, light, heat, and moisture, as any one of these agents will cause disintegration. The tubes containing the anesthetic tablets should always be kept well stoppered so as to exclude air and prevent contamination. (See Fig. 199.)

Arkansas Stone Mounted on Mandrel.—An Arkansas stone is used to sharpen the needles when they become dull. A stone, at least 2½ centimeters in diameter, should be employed, which will give the needles the proper bevel. A gold file can also be employed, but it is not so efficient or convenient as the Arkansas stone; besides, it is rather difficult to hold the needle at the proper angle with the file during the process of pointing. A dull needle inflicts pain and if the point is bent it has a tendency to deflect the course of the needle during its passage through the tissues, which may result in failure. The needles should not contain a long sharp point and bevel. The object of a short bevel is, *first*, it is more difficult to enter an artery; *second*, a long point is easily bent. (Fig. 178 shows the right and wrong way of beveling needles.)

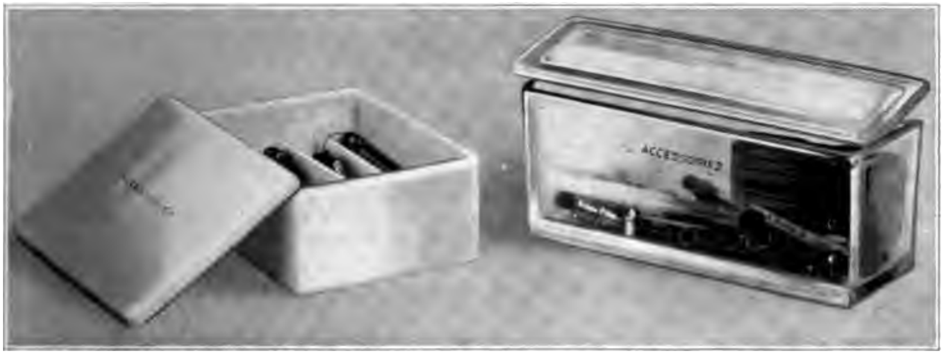


Fig. 199.—Receptacles for accessories.

The author's method of sharpening needles is shown in Fig. 183.

Fig. 200.—Arkansas stone for sharpening needles.

Receptacle for Iodin.—A glass or porcelain receptacle is employed for the iodin which is used as the germicidal solution for preparing the tissue before injection. It is applied to the tissue with a wooden applicator. The germicidal solution contains equal parts of 7 per cent tincture of iodin and ethyl alcohol. (See Fig. 194.)

Wooden Applicators.—Small wooden applicators, about six inches in length, are used to apply the iodin solution to the tissue. Fig. 220 shows the wrapping of the cotton around the applicator. After the cotton is wrapped around the end of the wooden applicator, it should assume the shape of a cone.

Artery Forceps.—Artery forceps are almost indispensable for block anesthesia work. A piece of gauze, about five inches square, is folded with the

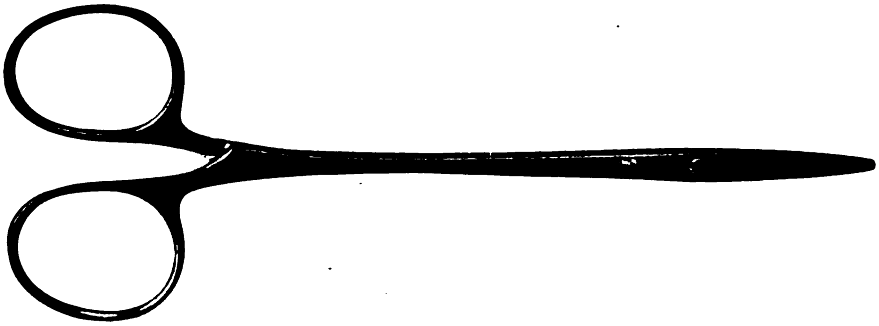


Fig. 201.—An artery forcep which is long and narrow is employed to retain the gauze or cotton pack for drying the tissues prior to applying the germicidal solution for the needle.

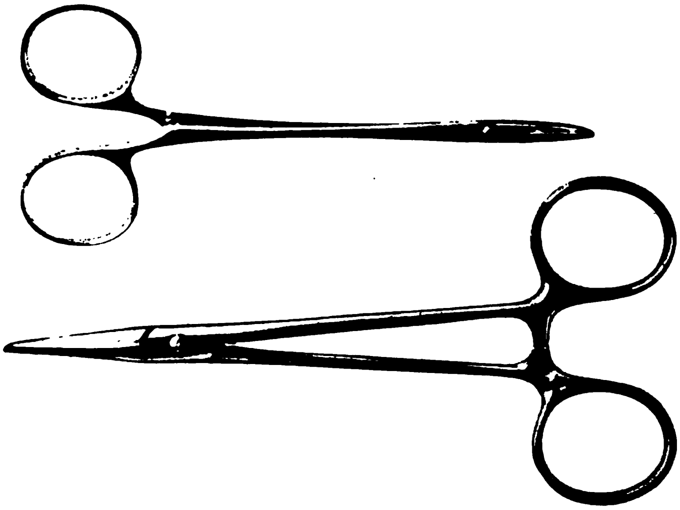


Fig. 202.—Small-size artery forceps, which are convenient in oral surgery operations.

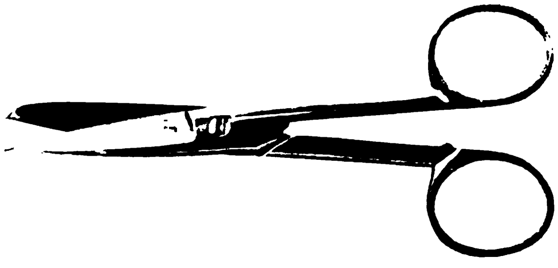


Fig. 203.—The Mayo surgical scissors.

edges turned inward (see Fig. 219), is held by an artery forceps and is used to remove the saliva and mucus from the tissue before the germicidal solution is applied. Two or three pieces of gauze should be applied to the part to render the tissue as dry as possible. The gauze is held firmly by the artery forceps, which is superior to cotton pliers.

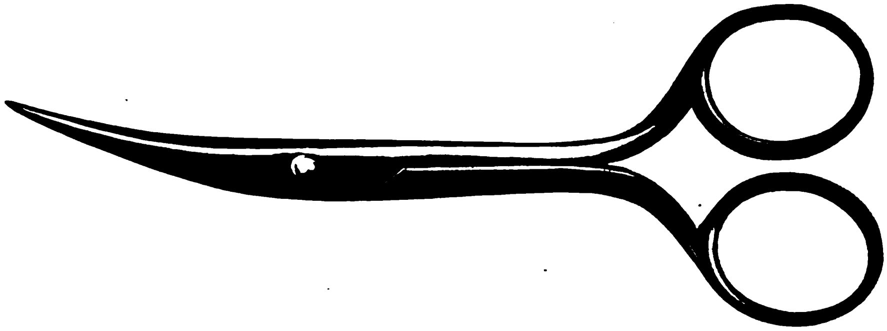


Fig. 204.—Surgical scissors. (Designed by Dr. George Winter.)

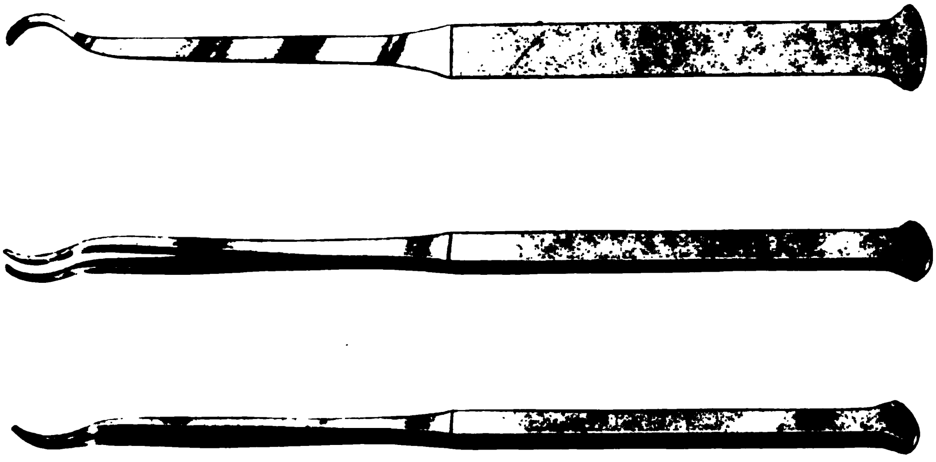


Fig. 205.—Intraosseous double-bladed lancet and retractor. (Designed by the author.)

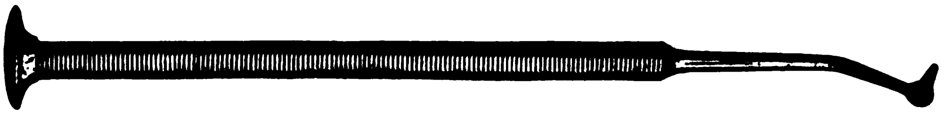


Fig. 206.—Intraosseous template or guide. (Designed by the author.)

Intraosseous Outfit.—The intraosseous outfit, which has been designed for producing diploic anesthesia, consists of the following instruments:

Intraosseous double-bladed lancet and retractor.
Intraosseous guide.
Intraosseous drill.
Intraosseous needles. (Nos. 1 and 7.)

Needle Extension Hub.—The needle extension hub, as illustrated in Fig. 208, is used in the blocking of the pharyngeal plexus which is one of the deep block injections for tonsillectomy. This extension hub is about three inches in length. Without an extension it is impossible to reach the posterior region of the oral cavity without inserting the greater part of the syringe into the patient's mouth.

Local Anesthetic Tablets.—The reader is referred to Chapters XIV, XV, and XVI. If a stock Ringer solution is to be employed as a vehicle, it is necessary to use at least two kinds of tablets, which are as follows:

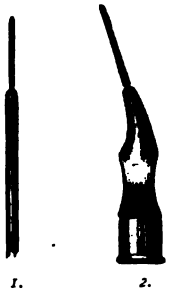


Fig. 207.—*1*, Intraosseous bibevel drill, 13 millimeters in length, which is a fraction smaller than the needle; *2*, Intraosseous needle, which is 10 millimeters in length and a fraction larger than the drill. (Designed by the Author.)

1. Ringer tablets.
2. Tablets, containing the anesthetic and vaso-constricting agent, adrenalin or synthetic suprarenin. (See Chapter XIX.)

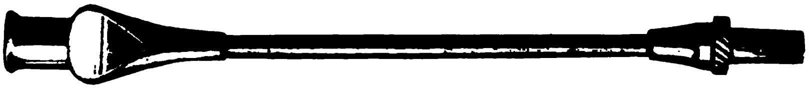


Fig. 208.—Tonsillar extension hub employed for the deep block injections for tonsillectomy. (Designed by the Author.)

Another method of preparing the injecting solution is to employ the following:

1. Ringer tablets.
2. Tablets containing only the anesthetic.
3. Stock solution of 1:1000 adrenalin chlorid.

Another method of preparing the injecting solution is to employ the following:

1. Ringer tablets.
2. Tablets containing only the anesthetic.
3. Tablets containing 1/1600 grain adrenalin or synthetic suprarenin.

Note.—Tablets containing different amounts of the vaso-constricting agent adrenalin or synthetic suprarenin can be secured. In most cases one tablet is added per each mil of the solution, but if a more prolonged anesthesia is desired two tablets are added to each three mils.

The author's method of preparing the injecting solution is to employ:

1. Freshly distilled sterile water.
2. Procain-suprarenin-Ringer tablets. One tablet is added per mil of sterile distilled water. (See Chapter XX on "Detailed Technic for Preparing the Injecting Solution.")

CHAPTER XIX

THE LOCAL ANESTHETIC VEHICLE

The injecting solution employed in the various forms of local anesthesia demands thoroughness of technic in its preparation.

Each of the following subjects will be considered separately:

1. Vehicle
    - Distilled water.
    - Ringer solution
    - Normal saline solution.
2. The Isotonic Solution.
3. The Hypotonic Solution.
4. The Hypertonic Solution.

Distilled Water as the Vehicle.—Distilled water, without the addition of Ringer constituents is not employed as a vehicle because it is hypotonic. The injection of distilled water for the production of peridental, submucous, or subperiosteal anesthesia, does not make such a vast difference, but when a large quantity of solution is injected by the block anesthesia method, nothing but an isotonic vehicle should be employed. Distilled water is not isotonic with the cell content, and when injected will cause expansion of the tissue cells. This change not only takes place in the tissues themselves, but also in the erythrocytes. This is one of the factors which causes postoperative pain. (See Chapter XXXV on Postoperative Complications and Treatment.)

Our teachings in physiology and the evidence resulting from research accomplished by numerous investigators are conclusive proof that none other than an isotonic vehicle should be employed.

Striking evidence of the swelling of the tissue cells and the hemolysis which may take place when distilled water, or, in other words, a hypotonic solution, is injected, is to add a small amount of blood and distilled water to a microscopic slide. Examine under the microscope. This examination will reveal the erythrocytes becoming larger until the membrane actually breaks and allows the hemoglobin to escape. This is due to the destruction of the osmotic balance. (See Fig. 211.) Pure distilled water should be used in preparing the injecting solution. Tap water should never be employed as it may contain such impurities as sodium, potassium, iron, magnesium, or bacteria, and when delicate compounds are added, such as suprarenin or procain, chemical change is liable to occur which may alter the desired therapeutic effect. The commercial distilled water, as obtained from the drug store, may be secured from the ice plant or laundry, which does not insure either purity or sterility by any means. When the operator secures distilled water from his local druggist it is dispensed in an ordinary glass bottle, and in many cases it is kept for an indefinite period of time, with dust collecting around the cork. Distilled water, which is kept indefinitely will undergo disintegration from the chemical constituents of the glass, such as lead, chromium, alkalies, etc. It is also changed by light, bacteria, etc. On aging a sediment and flocculent deposits are seen in the solution. It has been proved by many operators that a local anesthetic solution prepared from stale distilled water is far more irritating to the tissues than one prepared from freshly distilled water. The ideal way for the operator to obtain distilled water, and make sure of its purity, is to own his still and prepare a small quantity at least every other day, which should be kept in an alkaline-free container (see Figs. 191 and 192).

Ringer Solution as the Vehicle.—Years ago Ringer proved the presence of sodium, potassium, and calcium chlorids in the blood following extensive experiments, and since he presented his findings to the profession, Ringer solution containing the constituents has been almost exclusively employed in preparing a scientific local anesthetic solution. He found that by feeding an isolated frog's or terrapin's heart with normal salt solution it would continue beating for a considerable time, but the beats soon became weaker and gradually ceased. The solution he employed was .7 per cent sodium chlorid. He also found by removing the heart from the .7 per cent normal saline solution after the beats became weak, and immersing it in a solution containing the proper amounts of sodium, potassium, and calcium chlorids, it would immediately and vigorously increase the beat and the heart would continue to beat for many hours. When the three chlorids are added to sterile distilled water in the proper proportion, the product is known as Ringer's solution. The quantity of the three chlorids varies slightly with different individuals. The amounts which produce the greatest action on the heart of a terrapin or frog are as follows:

Sodium chlorid	0.7
Calcium chlorid	0.025
Potassium chlorid	0.03

It has also been shown that the mammalian heart is greatly stimulated and can be kept beating for several hours when fed with a physiologic, isotonic Ringer solution. In addition to Ringer's experiments Loche added wonderfully to the subject, and the accomplishments of these two investigators have resulted in increasing the efficiency of injecting solutions for local anesthesia and for the treatment of collapse and shock.

Considerable experimental work was done with the isolated mammalian heart with various percentages of the ingredients, and the mixture which has been recommended by both Loche and Ringer consists of the following:

Sodium chlorid	0.9
Calcium chlorid	0.024
Potassium chlorid	0.042
Sodium bicarbonate	0.02
Dextrose	0.1

They were able to keep the mammalian heart beating for many hours by feeding it with the above compound. Dextrose was found to be utilized by the heart as it disappeared from the solution in which the heart was immersed. It was also found that sodium bicarbonate increased the effectiveness of the solution, but was not considered as an essential constituent. Sodium, potassium, and calcium chlorids cannot be added at random, neither can other salts be employed. It has been proved that the three above-named chlorids in the proper proportions exert a very important part in the production of the rhythmical beat of the heart, and experiments have proved that all three chlorids have their specific role. Their presence is absolutely essential in the proper proportion for heart activity.

There has been more or less controversy among many investigators, with reference to the definite role played by each one of the salts. The normal osmotic pressure of the blood is more or less dependent upon the presence of sodium chlorid. A normal salt solution which contains only sodium chlorid is not sufficient to maintain various properties and normal composition of the various tissues as it only contains sodium chlorid, which is only one of the chlorids composing the modified Ringer formula.

In a Ringer solution the sodium chlorid breaks up into sodium and chlorin ions, and in addition to being the principal factor in maintaining osmotic pressure, it performs a special role in the origination and maintenance of the automatic beat of the heart.

The calcium chlorid breaks up into calcium and chlorin ions. It acts upon the heart muscle, producing contractility and irritability. If calcium is added in an amount greater than that of either sodium or potassium, it will produce what is known as a tonic contraction or calcium rigor, but, when added to sodium and potassium chlorids in the proper proportion, it is a stimulant.

The potassium chlorid breaks up into potassium and chlorin ions and acts upon the heart muscle which promotes relaxation and exercises the power of regulating the rate of beat. It will be seen from the above that all three chlorids have their specific functions.

If only a small amount of the local anesthetic solution is injected, as was practiced years ago by the peridental, submucous, and subperiosteal methods, the small amount injected would make very little difference as to whether or not it was isotonic. In block or infiltration anesthesia it is quite different, as considerable solution is injected, and it is necessary that the vehicle conform to the physical laws and functions of the living tissue cells.

With the advent of deep block anesthesia and the infiltration or regional methods, the problems confronting the operator are entirely different from those encountered years ago. A large quantity of solution injected into the delicate tissues must conform as nearly as possible to the tissue fluids and blood, to prevent tissue changes, which cause soreness, swelling, and postoperative pain. A properly prepared Ringer solution has the same osmotic balance as the tissue juices and blood, and when properly injected, no tissue changes take place. The solution is slowly absorbed, with no irritation or after-pain. The fact has been *proved by hundreds of operators in practice and in the clinic that Ringer solution is superior to normal saline solution (sodium chlorid) as a vehicle in local anesthesia.*

There are two ways of preparing Ringer solution. One method is to prepare a stock solution, and the other method is to prepare it at the time of injection. Stock Ringer solution is not preferable, inasmuch as it is an excellent culture medium for bacteria, especially at the temperature of the office. A stock solution upon examination will reveal floccular deposits, fungi and other deleterious material. The serious drawback in employing a stock Ringer solution is the necessity of boiling it for several minutes to insure its sterility, but after it is subjected to boiling for several minutes it is changed to a hypertonic solution, due to the evaporation during the process of boiling. This fact was first called to the author's attention by Professor W. D. Zoethout, physiologist, during experimentations in the physiological laboratory, and was the cause of extensive experimental work being done which has resulted in the elimination of the stock Ringer solution.

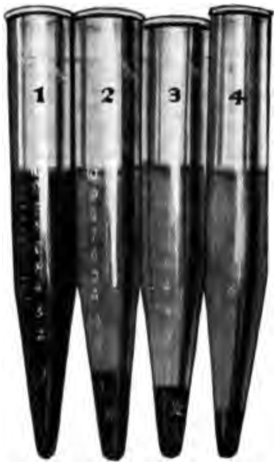


Fig. 209.—Experiments with hypotonic and hypertonic solutions.

In each test tube was placed three mils of blood. To Tube 1 seven mils of sterile distilled water (hypotonic) was added which quickly destroyed (hemolysis) the red blood corpuscles.

To Tube 2 seven mils of an isotonic (1.30 per cent) solution was added which caused the erythrocytes to collect in the bottom of the tube. Microscopic examination showed cells to be normal.

To Tube 3 seven mils of a hypertonic (1.70 per cent) solution was added which caused a rapid contraction and crenation of the erythrocytes.

To Tube 4 seven mils of a hypertonic (2.55 per cent) solution was added which caused a more rapid and greater destruction by crenation of the red cells than the 1.70 per cent solution in Tube 3.

Ringer constituents were employed in Tubes 2, 3 and 4. The hypertonic solutions were obtained by boiling the Ringer vehicle.

All four of the tubes were prepared and centrifuged at the same time.

Action of the Hypo-, Iso-, and Hypertonic Solutions on Blood, Muscle and Nerve Tissues.—(This joint work of Dr. Ira G. Nichols, Dr. J. F. Corbett, and the author, was carried out in the Department of Experimental Surgery of the University of Minnesota.) (See Figs. 209 to 218 E.)

We learn in bacteriology that to thoroughly sterilize a solution, it must be boiled for 15 minutes on three consecutive days, and if this was done with Ringer solution a large quantity would be lost in evaporation which would destroy its isotonic value. However, if care is taken it is not necessary to adhere to the laws laid down in bacteriology, for if Ringer solution is retained in a properly stoppered glass receptacle, boiling for four or five minutes will kill ordinary pathogenic bacteria. In boiling the solution for four or five minutes several mils are lost, thereby creating a hypertonic solution which will not conform to the physiologic laws and function of the living cells when deposited in contact with them. *The author regards this as one of the chief factors in the production of postoperative pain.*

Some operators prepare the injecting solution from an old stock Ringer solution which is absolutely unscientific. After Ringer solution has been prepared for several days, a sediment and flocculent deposit is seen floating in the container. Decomposition is also augmented by light, bacteria, and chemical compounds in the glass container, such as lead, chromium, alkalies, etc.

The writer's method for making a fresh Ringer solution is to add one tablet (containing the proper amount of anesthetic agent, vaso-constricting agent, and Ringer's constituents), to each mil of freshly distilled water, which has been rendered sterile by boiling. Any amount of solution may be prepared and the percentage of isotonicity and sterility is definitely known. If it is desired to prepare a stock Ringer solution, Ringer tablets are employed which contain the following:

℞	Sodium chlorid	0.050
	Calcium chlorid	0.004
	Potassium chlorid	0.002

Sig.: Dissolve ten tablets in 100 mils of sterile distilled water to make a stock Ringer solution.

If the solution is kept on hand as a stock solution, it must be boiled several minutes before the anesthetic tablets are added to insure sterility.

Normal Saline Solution.—Normal saline solution is prepared from sterile sodium chlorid and freshly distilled sterile water. Tablets containing 16-⅖ grains of sodium chlorid (C.P.) are employed. One tablet dissolved in four ounces makes a normal salt solution.

The following proportions are employed:

		Gm. or mil	
℞	Sodii chloridi (C.P.)	2	00
	Acidi hydrochloridi	0	06
	Aquae destillatæ	300	00

Normal saline solution, as a vehicle, is inferior to an isotonic Ringer solution because it does not contain calcium and potassium chlorids. Ringer solution augments the action of the local anesthetic, stimulates absorption, and is a nonirritant to the most delicate tissues. Hence, postoperative pain from this source is avoided. These facts are well known to experienced operators.

The Isotonic Solution.—An isotonic Ringer solution possesses the same osmotic pressure as the tissue fluids and blood and does not disturb the osmotic balance between the tissue cells. Local anesthetic solutions, therefore, should be physiologically isotonic to prevent tissue cell changes and postoperative pain. A physiologic isotonic solution, when injected into the tissue, conforms to the physical laws, physiologic properties and functions of the living cells, and no abnormal changes are produced. (See Figs. 210, 218-*D*, and 218-*E*.)

The Hypotonic Solution.—An isotonic solution, which has been diluted, becomes a hypotonic solution, because it does not contain the proper amounts of sodium, potassium, and calcium chlorids. When a solution of this character is injected, it causes a swelling of the tissue cells, because the fluid of the tissue cells is of higher osmotic pressure. (See Figs. 211, 215, and 218-*A*.)

This swelling of the cells and erythrocytes may proceed to the point of rupture of the cell membrane which is easily demonstrated by the microscope. This process is called hemolysis when applied to the erythrocytes of the blood.

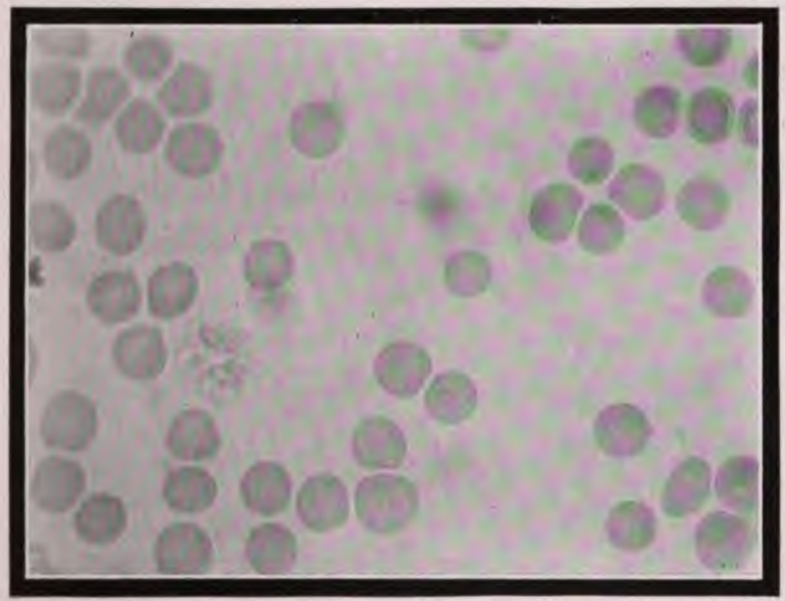


Fig. 210.—Microscopical view (950 x) of normal red blood corpuscles which have been placed in a physiologic, isotonic Ringer vehicle. The cells are normal in size and their rounded edges are distinctly shown. No change has taken place from the fact that they are contained in a Ringer vehicle which is physiologically isotonic. A local anesthetic solution should possess this important factor. One white blood corpuscle is seen to the left of the center of the field.

The Hypertonic Solution.—A hypertonic solution is one which contains an overamount of the chlorids, or, in other words, it is more concentrated than the isotonic solution. When such a solution is injected into the tissues it disturbs the osmotic balance in the tissue cells because it exerts a higher osmotic pressure. When injected, it rapidly absorbs water from the tissue cells until the osmotic pressure is equalized. A hypertonic solution is created when a stock Ringer solution is boiled for several minutes in order to render it sterile. The walls which surround the various cells are semipermeable membranes

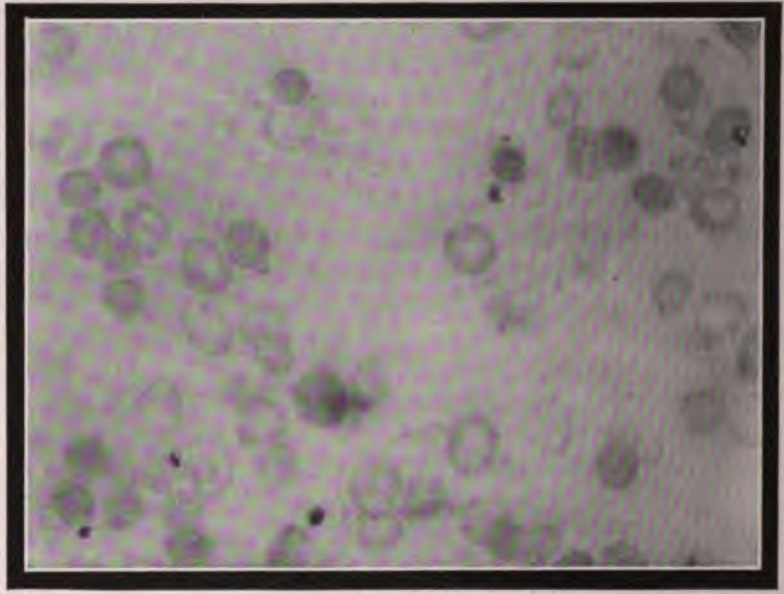


Fig. 211.—Microscopical view (950 x) of red blood corpuscles which were placed in a hypotonic (distilled water) vehicle. The cells are anemic and swollen due to absorption of water. Some of the cell membranes have ruptured due to absorption and distension.

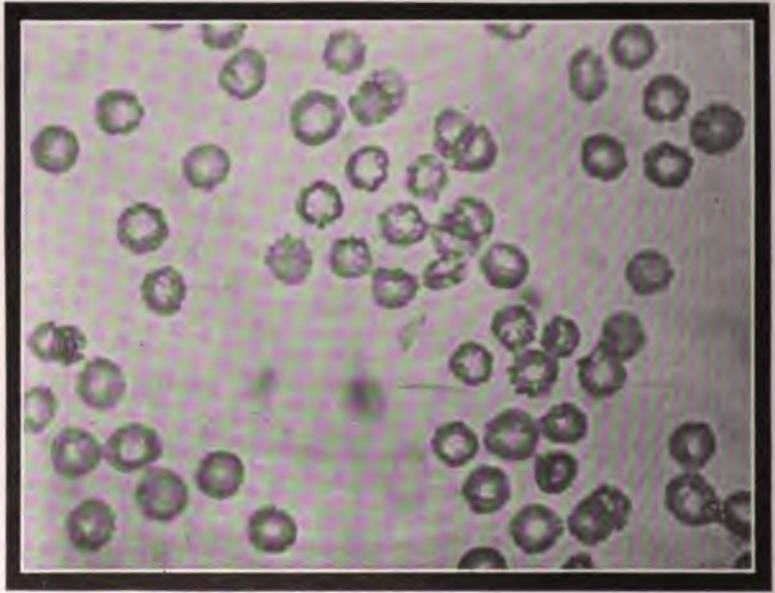


Fig. 212.—Microscopical view (950 x) of red blood corpuscles which were placed in an isotonic Ringer solution at a temperature of 130° F., which has caused great destruction to the red blood corpuscles due to heat above body temperature.

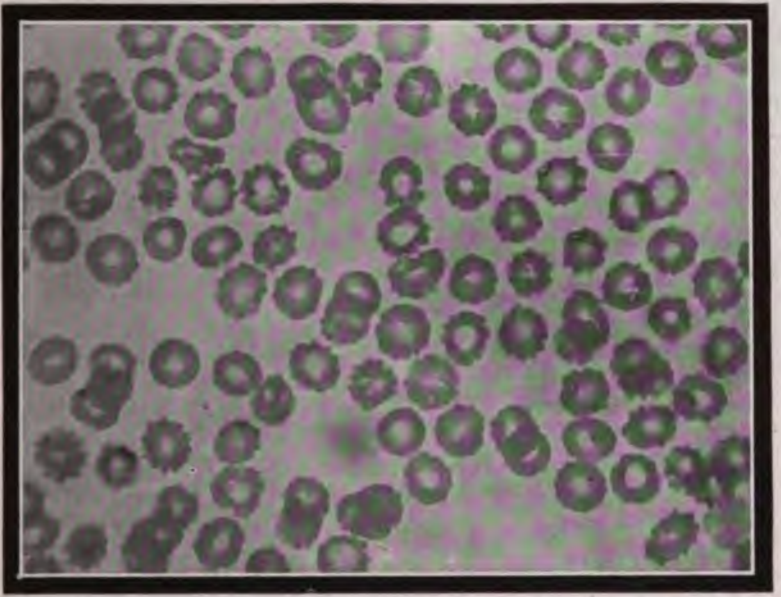


Fig. 213.—Microscopical view (950 x) showing destruction of red blood corpuscles which were placed in a hypertonic solution, prepared by boiling a stock Ringer solution four minutes. Every cell in the field clearly shows an irregular outline, contraction and crenation caused by the cell content being absorbed by the hypertonic vehicle to which they were subjected. This process is known as crenation.

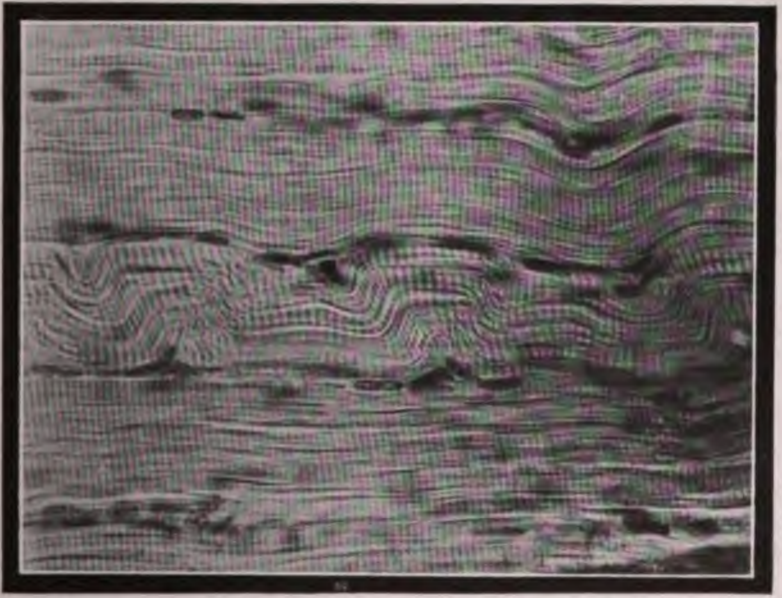


Fig. 214.—Microscopical view (500 x) of a longitudinal section of normal voluntary muscle of a rabbit. The various muscle stria and nuclei are clearly shown.

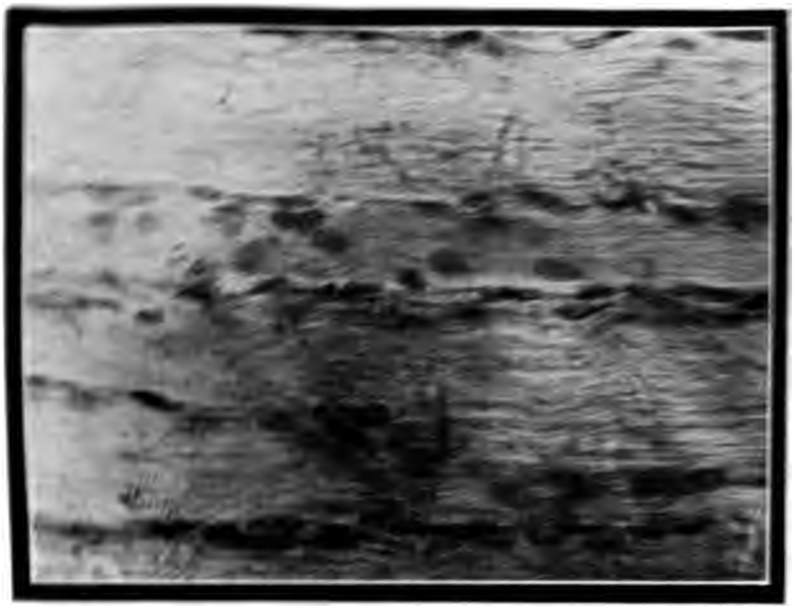


Fig. 215. Microscopical view (500 x) of a longitudinal section of voluntary muscle of a rabbit. The section was removed 24 hours after injecting a hypotonic (sterile distilled water) solution. The muscle fibers and cells are greatly distended and swollen, the tissue is edematous due to the excessive absorption.

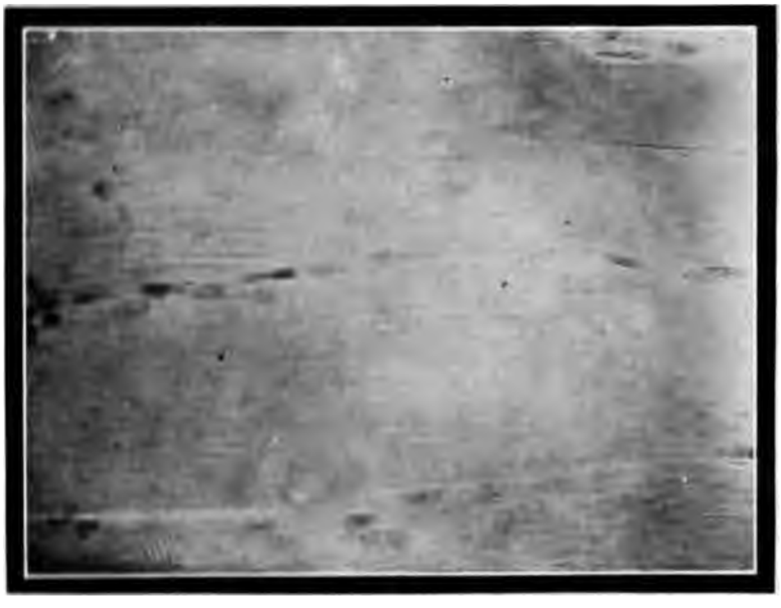


Fig. 216. Microscopical view (500 x) of longitudinal section of voluntary muscle of rabbit. Specimen taken from same region shown in Fig. 214, after being injected with a hypertonic (1.8 per cent) solution. This section was removed 24 hours after injecting the hypertonic solution into the muscle. The muscle fibers and cells are contracted and a cloudy condition of the tissue is clearly shown, which is due to the hypertonic solution. The stria have lost their identity.

through which the various solutions must pass. The injection of a hypertonic solution is an important factor in producing postoperative pain. (See Figs. 213, 216, 218, 218-*C*.)

Experimental Tests.—The author has many times advised his students to make three tests which give striking conclusive evidence of the necessity of injecting only physiologic, isotonic solutions into patients for the production of block anesthesia. These three simple tests are as follows: Take three microscopic slides and add one minim of fresh blood to each, then to slide No. 1 add a small amount of sterile distilled water which is hypotonic; to slide No. 2 add a small amount of isotonic Ringer solution; to slide No. 3 add a small amount of hypertonic solution. Take 2 c.c. of Ringer solution and evaporate down to one-half c.c. which makes a hypertonic solution. Examine each slide under microscope and observe the results. Within a few moments slide No. 1, which has the hypotonic solution, distilled water, shows the erythrocytes expanding, becoming globular in shape, and many of them will actually break, which is due to their enlargement as a result of excessive absorption. This process is called hemolysis. (See Fig. 211.) Slide No. 2, which contains the isotonic solution, reveals nothing so far as any destructive changes are concerned, but in contrast to slides No. 1 and No. 3, the normal erythrocytes are seen in the solution, retaining their normal size almost indefinitely. They retain their normal shape and size until external influences, such as air, cause them to undergo disintegration (see Fig. 210). Slide No. 3, which contains the hypertonic solution, shows the erythrocytes rapidly changing in form. Contraction is caused by the hypertonic solution which possesses a higher osmotic tension

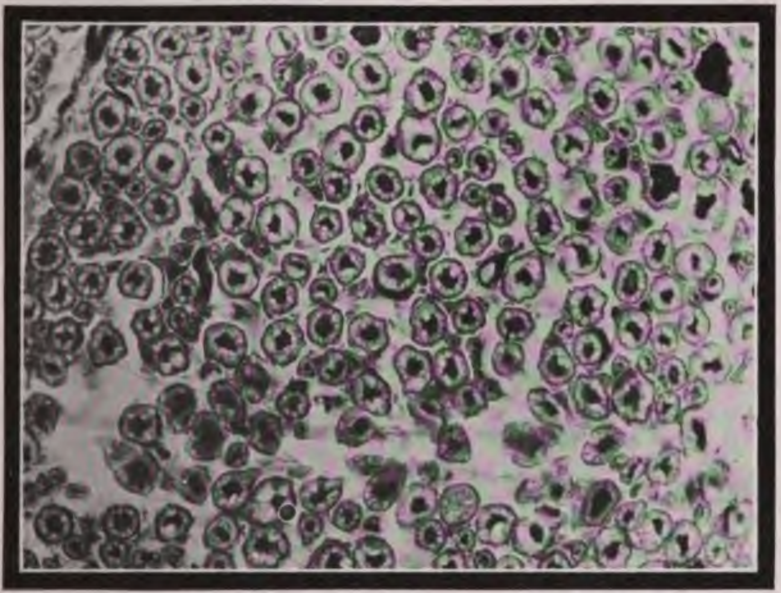


Fig. 217.—Microscopical view (450 x) illustrating a cross section of normal nerve tissue from the sciatic nerve of cat. The tissue was treated by the Cajah method in order to bring out the axis cylinder and neurilemma.

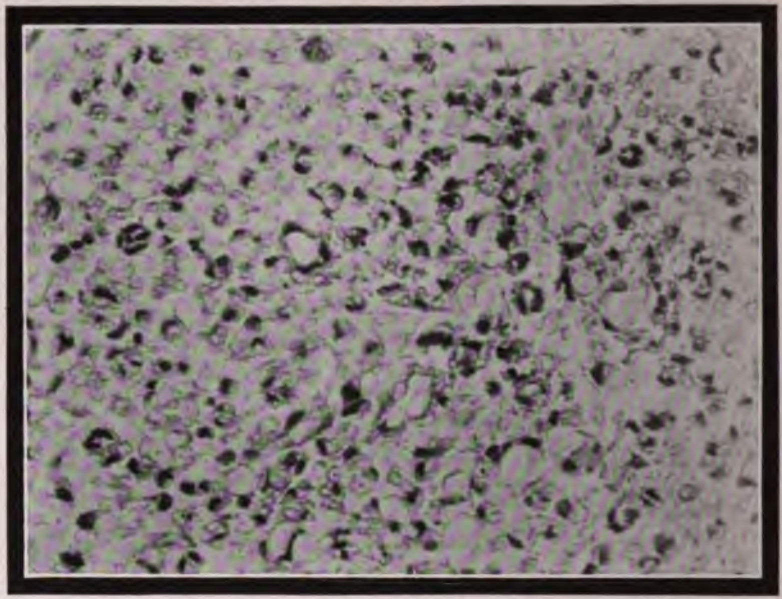


Fig. 218.—Microscopical view (450 x) of cross section of sciatic nerve of cat. The section was taken from the same region as section shown in Fig. 217, ten days after the nerve was injected with a hypertonic (1.2 per cent) solution which was prepared by boiling a stock Ringer solution. This section shows proliferation of syncytial cells of sheath of Schwan and increased intraneural connective tissue.

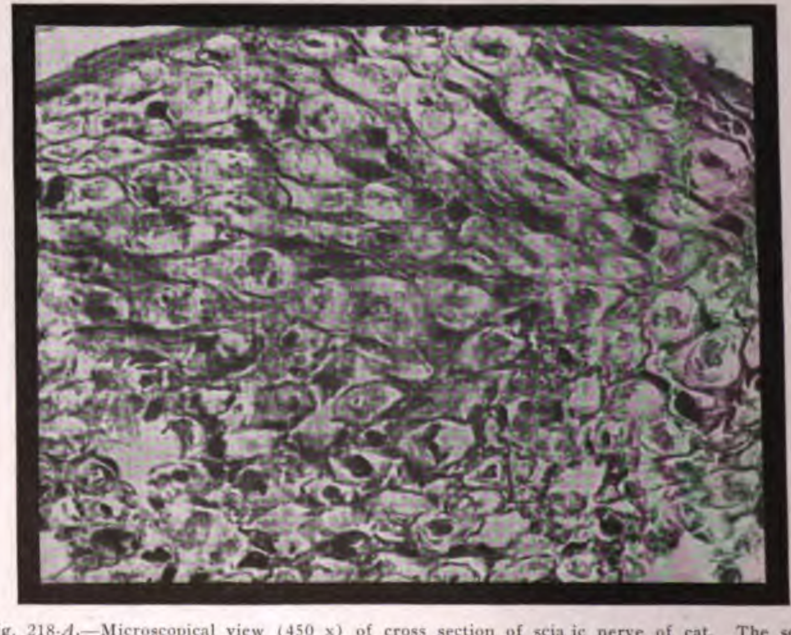


Fig. 218-*A*.—Microscopical view (450 x) of cross section of sciatic nerve of cat. The section was prepared ten days after the nerve was injected with a hypotonic solution. Swollen myelin.

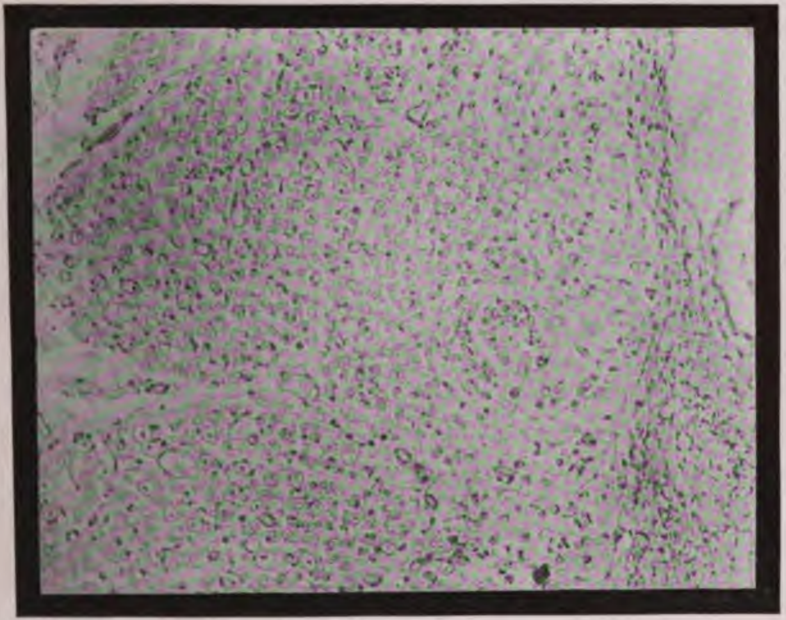


Fig. 218-*B*.—Microscopical view (110 x). Sciatic nerve of cat was injected with sterile distilled water. Section was made 30 days following injection. Specimen shows return of tissue change to normal. (See Fig. 218-*A* for change that takes place ten days following an injection of hypotonic solution.)

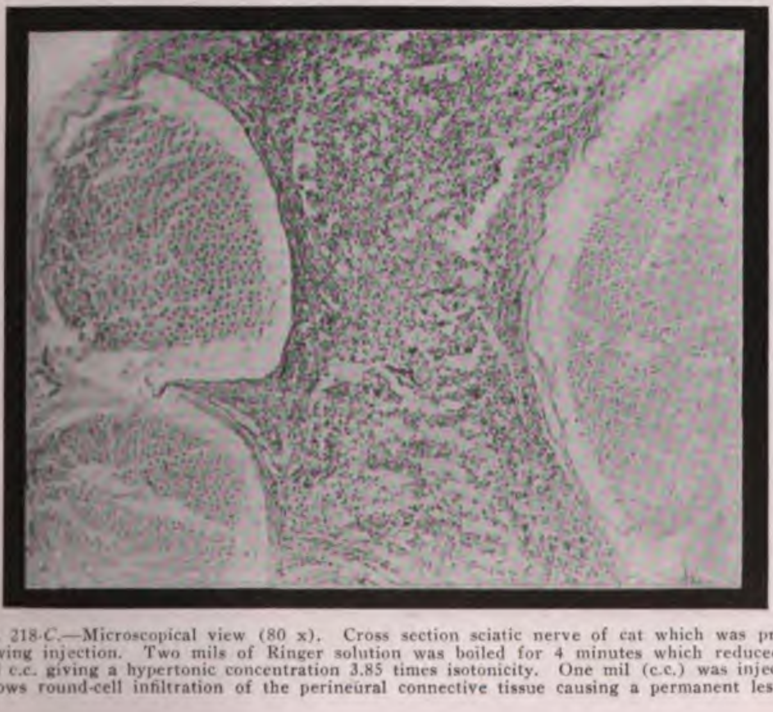


Fig. 218-*C*.—Microscopical view (80 x). Cross section sciatic nerve of cat which was prepared 30 days following injection. Two mils of Ringer solution was boiled for 4 minutes which reduced the volume to 1.3 c.c. giving a hypertonic concentration 3.85 times isotonicity. One mil (c.c.) was injected. The section shows round-cell infiltration of the perineural connective tissue causing a permanent lesion.

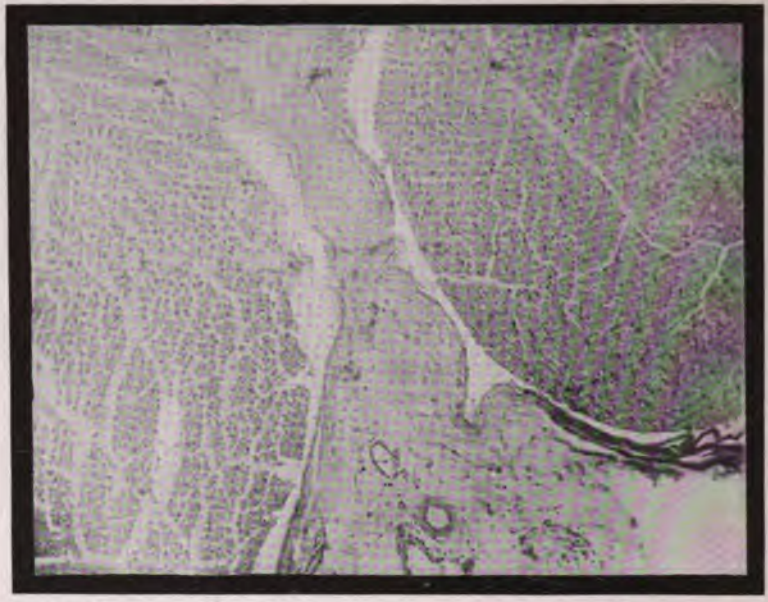


Fig. 218-*D*.—Microscopical view (80 x) of cross section showing sciatic nerve of cat. This section was taken from nerve at point of injection six weeks following the injection of 2 mils (c.c.) of a sterile physiologic isotonic Ringer solution. No change in nerve tissue.

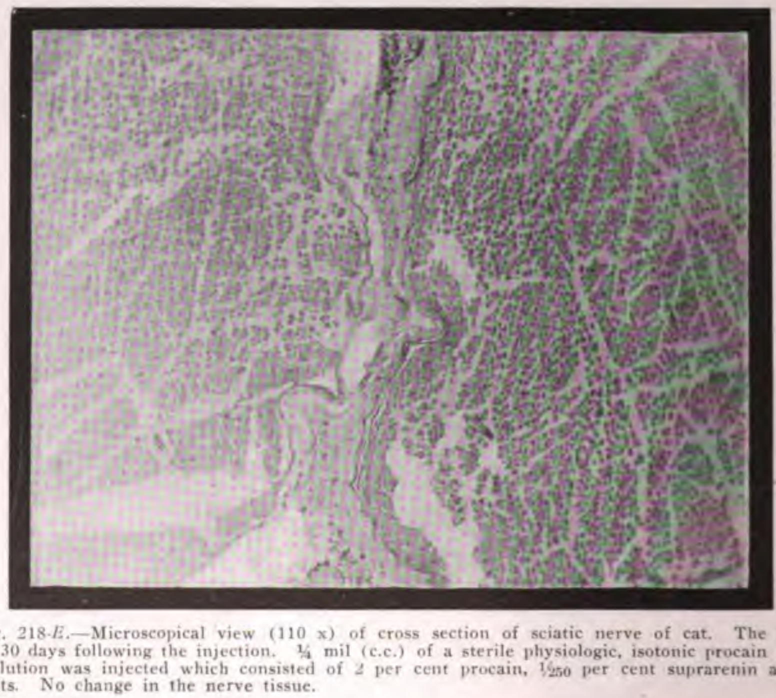


Fig. 218-*E*.—Microscopical view (110 x) of cross section of sciatic nerve of cat. The nerve was sectioned 30 days following the injection. ¼ mil (c.c.) of a sterile physiologic, isotonic procain suprarenin Ringer solution was injected which consisted of 2 per cent procain, 1/250 per cent suprarenin and Ringer constituents. No change in the nerve tissue.

than the corpuscular content (see Fig. 213). The hypertonic solution extracts water from the cells which causes a pronounced contraction, and such a process is called crenation. Such tissue change produces postoperative pain which can be avoided by employing an accurately compounded isotonic Ringer solution in local anesthesia.

It must be remembered that a properly prepared, warm, slowly injected physiologic isotonic Ringer solution produces no change in the tissue cells; they retain their normal size and function, and no irritation or postoperative pain is produced. The injection of a hypo- or hypertonic solution into the delicate connective tissue for the purpose of producing local anesthesia is poor practice and unscientific.

CHAPTER XX

DETAILED TECHNIC FOR PREPARING THE INJECTING SOLUTION

It is essential that the injecting solution contain the proper percentages of the various drugs in order to achieve the best results. The writer wishes to emphasize the fact that not enough attention is given by many operators to the preparation of the injecting solution. The local anesthetic solution should conform to the laws and principles worked out through scientific research. The following claims are in harmony with Braun's views, and in addition to his postulates, the author has added several requirements. The anesthetizing solution should possess the following:

1. For block anesthesia, the anesthetic drug employed should be far less toxic than cocain.
2. It is always advisable to prepare a fresh solution at the time of injection.
3. Old stock solution should not be employed.
4. Only pure, fresh, sterile, distilled water should be used in the preparation of the vehicle.
5. The operator should always know the amount of the anesthetic and vaso-constricting agent contained in the tablet he is using.
6. The solution must be sterile.
7. The solution should contain Ringer's constituents in the proportion to produce a physiologic, isotonic vehicle.
8. The solution should conform to the physiologic laws and functions of the living cells.
9. The anesthetic employed must be readily soluble in the vehicle.
10. The anesthetic must be capable of being absorbed.
11. The anesthetic drug must produce no pain, tissue irritation, or sloughing, and must not interfere with tissue repair.
12. The anesthetic drug must possess the property of being combined with the vaso-constricting agent adrenalin or synthetic suprarenin without interfering with the therapeutic action of either.
13. The anesthetic solution should be, at least, fairly stable.
14. The solution should contain only constituents which can be sterilized by boiling after the proper number of tablets have been added to the vehicle.

For injection, the strength of the solution containing Ringer constituents, the anesthetic and vaso-constricting agent depends upon:

1. The physical condition of the patient.
2. The nature and extent of the operation.

3. The amount of the solution to be injected, and the rapidity with which it is injected. (See Chapters XIII, XV, XVI and XXXVI.

For the patient who does not possess a serious organic lesion, or advanced arteriosclerosis, a number of deep nerve blocking injections can be made, and even on patients who do possess some pathologic condition, considerable quantity of the solution can be injected. (See Chapters XIII and XXII.) However, a close watch should be kept upon the respiration, blood pressure and pulse, and upon the first indications of unfavorable symptoms the injection of solution should stop. The operator should always see how little solution he can inject to produce the desired results, and if he always bears this in mind and does not attempt to anesthetize too large an area, he will seldom meet with any difficulty. A 1 per cent solution of procain will in many cases be sufficient to produce anesthesia, however, in some cases the anesthesia is not profound; in other words, it is light in character, which makes it inefficient for such operations as removal of the pulp, or the removal of a badly impacted third molar, etc. The author employs a 2 per cent solution in practically all his cases in oral surgery.

In preparing the injecting solution the operator must not only consider the toxicity of the anesthetic drug, but, in addition, the toxicity which may arise from the vaso-constricting agent, synthetic suprarenin or adrenalin.

The writer employs 1:1,600 grain (.00004) of suprarenin per each mil of the injecting solution for practically all cases of oral surgery.

When we consider all the factors involved, this is an ideal amount for the reason that a larger quantity of the solution can be injected with less chance of producing toxic symptoms. This amount of the vaso-constricting agent maintains a deep anesthesia for, at least, forty-five minutes, thus allowing the operator time, in most cases, to complete his operation. If the anesthesia begins to subside before the operator has completed his operation, a second injection can be made. For practically all purposes, a tablet which contains 1/3 of a grain of procain and 1/1600 of a grain of the vaso-constricting agent, synthetic suprarenin, is ideal, and the operator will find almost universal use for it in block, terminal, and intraosseous methods. However, in many cases a tablet containing .00002 gram (1/3200 gr.) of suprarenin is desirable. (See formula bottom of page 258.)

A tablet containing from 1/1200 to 1/600 of a grain of adrenalin or suprarenin will maintain anesthesia which lasts in some cases for several hours, and increases the possibility of producing toxic symptoms. (See page 271 for toxic symptoms produced by adrenalin and synthetic suprarenin.)

It is not difficult to prepare three different strength solutions, if they are desired. We shall use here for illustration tablets "T" and "E" and "F."

1. Tablet "T" contains .00002 grams (1/3200 grain) suprarenin together with .02 grams of procain. This tablet added to one mil of Ringer vehicle renders a 2 per cent solution of procain and 1:48,000 solution of suprarenin. The vaso-constricting content is low, which lowers the suprarenin toxicity, and the anesthesia will not be as prolonged as if it contained more of the vaso-constricting content.

2. Tablet "E" contains the same amount of procain as tablet "T," but instead of .00002 grams of suprarenin, it contains .00005 grams which produces a deep ischemia and a longer period of anesthesia than is produced by tablet "T." One of these tablets added to one mil of Ringer solution renders 2 per cent of procain and 1:20,000 solution of suprarenin. This tablet contains more than twice as much of the vaso-constricting agent as tablet "T."

3. Tablet "F" contains no suprarenin, but contains 5/6 gr. (.05 grams) of procain. If a small amount of the vaso-constricting agent is desired, take one "E" tablet and two "F" tablets and dissolve in six mils of Ringer's solution, which will give a 2 per cent solution of procain, and 1/100,000 solution suprarenin.

Method of Preparing the Injecting Solution from Tablet "E".—The desired amount of Ringer solution is placed in the sterile anesthetic dissolving graduate from the stock Ringer flask and is boiled for four or five minutes to render it sterile. The desired quantity which is to be injected is retained; for example, we shall say five mils. Now add five "E" tablets which contain procain .02 gm. and synthetic suprarenin .00005 gm. After the tablets are dissolved, bring solution to boiling point only, allow it to cool and it is ready for injection. This solution contains 2 per cent procain and 1/20,000 solution of the vaso-constricting agent, suprarenin. If 1 per cent solution of procain is desired, add one tablet per each 2 mils of the vehicle which will also give one-half the strength of suprarenin content.

Preparation of solution from tablet "T" and other tablets containing only the anesthetic and suprarenin content is prepared in a similar manner to that of solution from tablet "E".

The disadvantage of boiling a stock Ringer solution for several minutes is that its isotonic value is changed, and a hypertonic solution is created due to evaporation of the water. The writer considers this one of the principal causes of postoperative pain. One mil of Ringer's solution contains .005 grams of sodium chlorid, .0004 grams of calcium chlorid, and .0002 grams of potassium chlorid. Therefore, if an old stock solution is boiled for several minutes in order to render it sterile, the percentages of the chlorids are changed to those of the hypertonic solution. Therefore, it is always advisable to employ a Ringer solution which has been prepared for a short time only; preferably, it is better to make it daily from Ringer tablets.

Author's Method of Preparing the Injecting Solution.—A stock Ringer solution is not employed for the reasons set forth above. The desired amount of freshly distilled water is placed in an accurately graduated pipette (see Fig. 218-*F*). In order to make sure the water is sterile, it is boiled for four or five minutes, and the water that is lost in evaporation makes no difference because it does not contain the chlorids composing Ringer constituents.

To make a procain-suprarenin Ringer solution containing 2 per cent procain and 1/25,000 solution or 1/50,000 solution of the vaso-constricting agent, plus a fresh Ringer solution, all at the same time, dissolve the proper tablet in one mil (16 minims) of distilled, sterile water. For example, suppose one should desire to prepare 5 mils of the injecting solution; then place 6 or 7 mils of distilled water in the procain dissolver (always add an excess of distilled water to allow for evaporation) and boil for four or five minutes to make sure the water is absolutely sterile. Then pour off any excess and retain the desired 5 mils. Next add one tablet for each mil (one c.c. or 16 minims), and allow tablets to dissolve, after which bring the solution to the boiling point only. Attention is called to the fact that the distilled water is boiled before any ingredient whatsoever is added. The combined tablet is added in accordance with the number of mils (c.c.) desired, which renders a fresh isotonic, physiologic Ringer solution, 2 per cent of procain, and 1/25,000 or 1/50,000 solution of the vaso-constricting agent suprarenin.

Precautions Regarding Tablets.—Tablets which are dispensed by the leading pharmaceutical houses are scientifically compounded and chemically accurate, and precautions are taken to produce sterile products. The tablets should be contained in amber-colored vials which should be closed with a cork and carefully sealed, in order to prevent external contamination. Most local anesthetic tablets are affected by light, heat, air and moisture, and great care should be exercised in not exposing them to any of these influences, or allowing them to come in contact with anything which is not sterile for fear of disintegration and contamination.

When the solution is being prepared, never touch the tablets with the fingers, or pour them out in the hand, for fear of contamination. The required number of tablets can be dropped from the vial into the vehicle, or they can be placed upon sterile gauze or cotton for counting, then placed, with sterile pliers, in the graduate which contains as many mils (c.c.) of sterile Ringer solution or distilled water as the number of tablets added. The tubes containing the tablets should always be closed immediately by replacing the cotton and stopper, and then placed in some suitable container which will exclude them from air and moisture. (See Fig. 199.)

Precautions Taken With the Syringe and Needle.—The proper needle is selected and removed from the sterilizing jar along with the syringe. Distilled water is drawn through the needle into the syringe and is discharged outside the tube. (See Fig. 218-*F*.) This process should be repeated at least four times to make sure all traces of the antiseptic solution are removed. After the syringe is filled, care should be taken not to allow the needle to come in contact with anything that is not sterile. This may occur if the syringe is placed on the dental cabinet or instrument bracket. The author advises placing the platino-iridium needle in the flame and bringing it to a red heat just before inserting it into the tissue. Great caution should be exercised to prevent the sterile needle from coming in contact with the tongue, mucous membrane, or teeth while being inserted into the desired region. After the area has been thoroughly dried and prepared by means of the germicidal solution it must be kept free from mucus or saliva to avoid carrying infection into the tissue.

The reader will undoubtedly observe that special emphasis has been placed on asepsis in many parts of this text. However, it is a subject that requires special stress because it means so much to the operator and patient.

The Temperature of the Injecting Solution.—It is highly important that the temperature of the solution be near that of the body to avoid tissue irritation. In case the solution is very hot when injected, it will produce hyperemia and destruction of tissue, which is usually followed by postoperative pain. (See Fig. 212.)

Moral has proved in his research work that the anesthetizing power of the injecting solution is greatly influenced by the temperature, and that it should be near body temperature (98.6° F.), when injected.

An anesthetic solution near body temperature has a greater anesthetizing power than one which is of a higher or lower temperature. The writer has often observed operators filling the syringe with a solution just taken from the flame, and immediately injecting it into the tissues without allowing it to cool. If the syringe is removed from boiling water, and filled with a solution just removed from the flame, several minutes should elapse before injecting. If the syringe is taken from the antiseptic solution contained in the sterilizing jar, and all traces of the antiseptic removed, the anesthetizing solution may be injected immediately, as the temperature of the syringe will reduce the temperature of the solution, even though it has just been removed from the flame.

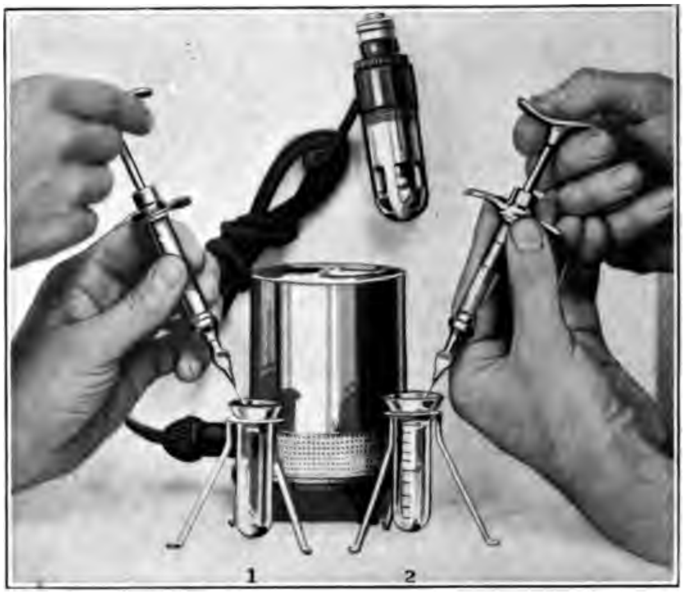


Fig. 218-F.—Anesthetic tablet dissolver and sterilizer. This electric device is used for sterilizing distilled water, for preparing the local anesthetic and for rinsing the syringe and needle.

No. 1 illustrates drawing the sterile distilled water into the syringe. No. 2. Filling the syringe with the anesthetic solution from an accurately graduated 10 mil (c.c.) receptacle. (Designed by the author.)

If the solution has been allowed to stand for several minutes, it is good practice to warm it before injecting.

The tablet method of preparing solutions is preferable to that of the stock solutions, because the solution is fresh at the time of injection.

CHAPTER XXI

GENERAL CONSIDERATIONS OF OPERATIVE TECHNIC

Conditions of Operation.—If the operations of the oral surgeon are of the same high type which characterize other branches of dentistry, rapid recovery without complications will be assured following operations under block anesthesia. There is probably no field of surgery demanding anesthesia which should afford better results than oral surgery and operative dentistry. The patient who requires surgical or dental treatment is usually in good health and there is little or no depression following the deep nerve blocking injections, if they are properly given. A factor in favor of nerve blocking is that it renders the field more free from hemorrhage than when a general anesthetic is employed, especially if the general anesthetic is one that causes an increase in blood pressure.

Asepsis.—Successful surgery is clean surgery. Antisepsis is the destroying of septic conditions in wounds or tissues by the use of a germicidal agent. Asepsis is the practice of thoroughness in a wound already sterile. Sepsis is a condition where specific or infective bacteria exist, and where inflammation in some degree follows. It is needless to say that absolute adherence to asepsis must be followed in all forms of local anesthesia injections, but more especially in the blocking of the deep nerve trunks.

Asepsis is defined as the absence of infection or the freedom from infective agents. The effort should always be made with all operations, minor or major in character, to secure and maintain scrupulous surgical cleanliness, and if there is any technic in the practice of dentistry that needs to be executed with strict adherence to asepsis it is certainly nerve blocking.

The credit for the antiseptic method of operating belongs to Lister, and the aseptic method is but a natural evolution of the antiseptic method. The simpler the operative technic in preparing the operative field, the better and more certain it is to be carefully carried out. The great physician Desault said, "The simplicity of preparation for operation is the measure of its perfection." Surgical cleanliness is obtained by one of two methods, antiseptic or aseptic. If the aseptic method is used, heat and chemical germicides are employed for the sterilization of instruments, the preparation of the field of operation, the hands of the surgeon, dentist, and assistants, the surface being freed from the chemical germicides by scrubbing with water which has been boiled or with saline solution. After the incision has been made, the practice is to apply no germicide, but simply sponge the wound with gauze which has been sterilized by heat. If it is necessary to irrigate a wound, Dakin's solution, sterilized distilled water, or sterilized Ringer solution at 105° F. is used. The wound is either dressed or packed with sterile gauze, this depending, of course, upon the nature of the operation. The thought that is always in the mind of the oral surgeon or dentist is to prevent the entrance of pathogenic bacteria into the tissues, and this important feature should not be overlooked when deep nerve blocking injections are being made, because the needle is carried to a considerable depth into the tissues. Doubtless there are a few pathogenic bacteria that enter a wound following an operation, but if the wound has been treated in accordance with the rules of asepsis, the number of them will be so small that they are readily destroyed by the healthy tissue, especially if the patient's resistance is normal. If no chemical germicides are applied to the wound, there will be only a small amount of irritation, with very few cells destroyed. The amount of exudation will be very small, and in many cases drainage can be dispensed with, thus making recovery extremely rapid. In case of a surgical procedure in the mouth, it is very essential that each bleeding point is stopped by ligation. In case the wound is closed without applying a drain, some compression should be made over the wound to obliterate any cavity, for if such a cavity should exist, it would be a dead space, and if allowed to remain, exudation from the tissues would accumulate and have a tendency to lower the tissue resistance and may become infected. If the antiseptic method is used, the same preparation for the operation is made as for the aseptic method, with the exception that during the operation a chemical germicide is applied to the tissue by gauze sponges, and the postoperative dressing of the wound contains a germicidal agent. In case a chemical germicide is neither applied to the wound nor used in irrigation, with the final application of a dry dressing, the procedure would be classed as the dry antiseptic method. When operating in an infected area, the antiseptic method is preferable; that is, an efficient germicidal agent is applied by means of gauze. Most operators prefer the dry sterile dressing rather than moist dressings in treating aseptic wounds, because the gauze is not an absorbent and does not act as a poultice.

Many methods of irrigation of wounds have been presented to the profession since the European war. Gratifying results have been obtained through the proper application of the Carrel-Dakin solution following the technic developed by Carrel. It is believed by some surgeons that they have obtained equally as good results from the irrigation of the wounds continuously, or moistening the dressing at intervals with Ringer solution. There is no question as to the value of irrigation of a septic wound to remove the toxic material and bacteria as well as to neutralize poisonous materials. The above-named solutions are advocated in many cases of antrum infection or infected sockets and can be used with satisfaction. The aseptic method is becoming more popular with the leading operators of the country. If the operation is upon the skin, mechanical cleansing removes great numbers of bacteria, epithelial cells, grease, and dirt. All bacteria cannot be removed by mechanical process, but a large number of them are removed, which greatly lessens the chance of infection. If a germicide is applied to the skin before the mechanical cleansing, its value is lessened because the oily material, dirt, and grease will prevent the germicide from reaching the bacteria; but after the mechanical process the germicide has greater power and can reach the bacteria which are on the surface. A strong germicidal solution cannot be used upon the mucous membrane in the oral cavity, but a mild solution must be employed, and it is of the utmost importance that all saliva and mucus be removed before the solution is applied. If a strong solution should be applied to the oral mucous membrane as is used upon the skin, it would cause destruction of the delicate tissue.

There are many facts which have been established by scientific research within recent years in dentistry with reference to mouth hygiene and the rendering of the parts aseptic. These facts have commanded the strictest attention of the members of the profession, especially as they relate to the various modes of treatment wherein asepsis plays an important role.

There is nothing a dentist can do to maintain the confidence of his patient more firmly than eternal vigilance in every operative procedure which relates to the sterilization of instruments and personal cleanliness, followed by absolute thoroughness in his technic. Aseptic operating is demanded by learned patients and they have a right to demand it, and the dentist who does not practice aseptic dentistry, or the oral surgeon who attempts to operate without adhering to the strictest rules of asepsis, is certainly not rendering the highest class of service, and is inviting trouble.

The advances which have been made in recent years in the treatment of various pathological conditions of the oral cavity, teeth and jaws, have been tremendous and rapid; the literature relating to this important subject has been prolific in dealing with scientific articles of merit, and it would seem that there is no end to the research which can be done on this important subject. Any oral surgeon or dentist engaged in practice, who wishes to build a reputation of merit, can not fail to observe the necessity of familiarizing himself and keeping in close touch with everything that pertains to the systematic treatment of all pathological conditions, and by prescribing and employing the recognized preparations and technic.

Many different forms of microorganisms are present in the mouth, and we must be very careful in considering all pathological conditions. Any operation within the bounds of the oral or dental surgeon should be performed under the most rigid principles of asepsis. The puncture of the mucous membrane for the insertion of the needle seems of little importance to some practitioners, and while it is true that the tissue tolerates numerous punctures, it is inevitable that the practitioner, who disregards thorough preparation of the tissue for the needle, or the preparation of the part for operation, will have cause for regret.

The deep block injection is different from the other forms of local anesthesia, and if infection should follow, no doubt it would be more severe than should infection follow an infiltration injection. The infiltration injection is superficial, while deep block injections vary as to the depth, depending upon the distance the nerve trunk is from the surface. If the oral tissues are inflamed, the needle should be inserted with caution. If infection exists in the oral tissues, the extraoral method of blocking is advantageously employed for such operations as fracture of inferior or superior maxillary bones, or for the removal of impacted third molars, curetting of the antrum, resection of the jaw, alveolectomy, extraction of a number of teeth, or in many cases of infection within the oral cavity, producing partial or complete closure of the jaws.

TECHNIC REQUIREMENTS

It needs no argument to convince the reader that more gratifying results are obtained in any branch of dentistry or oral surgery if a definite technic is followed. The idea of "any old technic" must be discarded. As has been repeatedly remarked in this text, block anesthesia demands a well-defined, skillful technic, and if every detail is given the greatest consideration, the operator will be more successful and his patients better satisfied.

During lectures and clinics the author has repeatedly stated: Be thorough and follow a definite technic. Pay attention to every detail and never sacrifice thoroughness for speed.

The requirements of technic may be enumerated as follows:

1. There should be strict adherence to asepsis at all times.
2. A thorough knowledge of the anatomic parts is very essential to make deep nerve block injections.
3. Equipment should be carefully selected.
4. The technic must be mastered.
5. Judicious selection of the method to be employed in each individual case.
6. Diagnosis of any and all existing conditions.
7. The use of an isotonic anesthetic solution composed of ingredients corresponding to the physical laws of osmotic pressure and physiologic function of the living cells.

These requirements have been very thoroughly discussed elsewhere in this text, and the writer hopes that a repetition of them will serve to impress the reader with the importance of each subject.

Failure in Block Anesthesia

There are few men in the professional world who have attained any great degree of success without having worked diligently for it. As there are no achievements without labor, so there can be no success worthy of the name that has not caused the possessor numberless nights of hard mental toil. Failures occur not only to the professional man, but to those in all walks of life. Those who do not advance in this day and age of modern efficiency are standing in their own light and are a source of great disadvantage to our honored profession.

A professional man should endeavor to profit by his failures, and consider them stepping stones toward success and never allow such failures to discourage him. Failures, therefore, are encountered, not only in the practice of block anesthesia, but in all branches of dentistry, and they should be a stimulus and inspiration for further research, study, and thoroughness. Most failures met by the operator in the various branches of local anesthesia, after he has once thoroughly learned the technic, are principally due to overlooking some of the details. Success with local anesthesia in its various branches is not 100 per cent perfect, but the failures encountered should not in any manner discourage the operator and cause him to cast aside a method with which he should be thoroughly familiar. One finds consolation in the fact that he has had failures in other branches of the profession. In most cases a failure in local anesthesia is not followed by any serious consequences; whereas a failure in general anesthesia may entail more serious results. The few failures in the various branches of local anesthesia are really of minor importance when the advantages afforded the operator are considered. The author believes that most failures can be overcome with perfected technic, and by studying the cause of such failures guard against their recurrence.

The following causes of failure will be considered separately:

1. Failure due to imperfect technic which results in imperfect anesthesia.
2. Failure due to the psychic condition of the patient.
3. Symptoms arising during or following the injection of the solution.
4. Postoperative complications.

The above factors mean a great deal to the operator, and for the past few years they have been the subject of considerable discussion among the members of the profession.

Failure Due to Imperfect Technic Resulting in Imperfect Anesthesia.—The writer classifies the causes of failures coming under this heading as follows:

1. By not following the proper technic.
2. By not having mastered anatomy—the location of the nerve branches and their relation to other anatomic structures, etc.
3. From not depositing the solution near the nerve branch.
4. By injecting the solution into ligaments, muscles or beneath the periosteum.
5. By inserting the needle in the wrong direction.
6. By employing inefficient instruments, such as needles which are too short or blunt, or a leaky syringe.
7. By injecting a solution containing too low or too high a percentage of the anesthetic drug.
8. By injecting a solution which contains too great a percentage of the vaso-constricting agent, suprarenin. The solution may not readily infiltrate a nerve branch if the vaso-constricting agent is excessive in amount, or if it is of too low percentage, the anesthetic will be absorbed too quickly.
9. By the solution not containing a sufficient amount of the vaso-constricting agent which produces a light anesthesia.
10. By injecting a solution containing deteriorated drugs.
11. From not injecting a sufficient quantity of the anesthetizing solution to block the nerve trunk.

12. From employing an anesthetic solution which does not conform to the practices and principles of modern block anesthesia.

13. By injecting the solution into an inflamed or abscessed tissue.

14. By not holding the bevel of the needle toward the periosteum.

Failure Due to Psychic Condition of the Patient.—Local anesthesia will relieve pain produced by trauma, but it does not eliminate psychic fear. The psychic feature is the greatest drawback the operator has to contend with, and he should, at all times, practice tact, accuracy, and psychotherapy. The operator who does not practice these principles will fail many times, although the failure may not be ascribed to any of the fourteen factors above mentioned, but may be due to the inability of the operator to handle his patient properly. The value of psychotherapy during the administration of a local or general anesthetic cannot be overestimated.

The following causes of failures are principally due to the psychic condition of the patient. Use every precaution to overcome them.

1. Previous experience of the patient.

2. The patient's fear and dread of pain.

3. Allowing nervous patients to see the hypodermic and needles, instruments, other paraphernalia which should be concealed from view.

4. The operator or assistant not practicing diplomacy in his conversation relative to the operation, which may create distrust and resistance of the patient.

5. The operator inflicting pain during the initial prick of the needle. The operator should never cause the slightest pain at the beginning, but should always lead up to each point, step by step. He should always inject the solution regardless of the location of the needle, if the slightest pain is experienced by the patient.

6. Inform the patient that you are not injecting a powerful toxic drug like cocain. Most patients have a horror of having cocain injected into them.

7. If the operator is not positive as to his *modus operandi*, patients will notice it very readily, as they are very apprehensive of these facts under such conditions.

8. Inform the patient of the sensation of the approaching anesthesia, and that they will feel the application of the instrument, the tooth leaving the socket, or the cutting of the bur, etc., but will not experience pain.

Essential Factors Underlying a Successful Injection of the Solution

Many dentists are under the impression that the greater part of the technic lies in the solution injected. This point is of great importance, but it does not mean that the operator will secure satisfactory results from the injection, if he overlooks any of the other important factors.

The solution must be carefully prepared, and must contain ingredients in conformity with the physical laws and physiological functions of the tissue cells, and be near body temperature. The instrument used, such as the syringe, needle, etc., must be carefully selected and kept in proper working condition, and by all means absolutely sterile. The operator must be familiar with the anatomy at the location of injection, and should be able to detect any pathologic conditions which may exist. The patient should be given an examination and the part to be blocked should be thoroughly considered. The operator must not be too hasty in deciding upon the injection or injections to use. After the operator is thoroughly convinced as to the injection he is to use, the operative field should be carefully prepared.

Not infrequently operators complain that they do not secure good results from some form of local anesthesia. In these cases the operator is usually at fault, owing to the fact that he has overlooked some single factor in the technic which has impaired the desired effect. Many of these operators will immediately blame the method or the anesthetic solution which they are using, the hypodermic syringe, or some other part of the armamentarium, while the failure may be attributed to carelessness or incompetency on their part in executing the technic in the proper manner.

CHAPTER XXII

THE PATIENT

[illegible] subjects will be discussed in their order:

[illegible] patient.

[illegible] within the oral cavity.

[illegible] the insertion of the needle.

[illegible] the patient.

[illegible]

[illegible]

[illegible]

[illegible] an injection.

[illegible] operator should disregard the thorough [illegible] patient prior to the administration of a [illegible] general anesthetic is to be administered, it is [illegible] which is more elaborate than is [illegible] quite true that all those factors which [illegible] patient for the administration of a [illegible] of a large quantity of local [illegible] is not essential to carry out [illegible] as it is with a general anes- [illegible] all the little details and knows just [illegible] much time and anxiety.

[illegible] of the patient, and the duties [illegible] and if the assistant possesses [illegible] operator. The preparation of the [illegible] extent of the operation, and the [illegible] general facts.

[illegible] time, may be in a highly nervous [illegible] number of teeth to be extracted, or [illegible] pathologic condition and has lost a [illegible] always advisable to allay mental [illegible] accomplished not only by the [illegible] assistant plays an important role.

[illegible] the patient is advisable, especially [illegible] and lungs. In making this statement [illegible] impression that this is necessary in all [illegible] the reader with the fact that some cases [illegible] observation. If the patient is elderly and [illegible] possessing a weak or irregular pulse, with impaired vitality, he will require careful treatment. According to Dr. Rosenow of Mayo Clinic, Dr. Hartzell of the University of Minnesota, and Dr. Price of the National Dental Research Institute, it is not advisable to extract a number of teeth at one sitting if the patient is a victim of focal infection. The number of infected teeth which can be removed at one time should be determined by the apparent resistance of the patient. It is often difficult to determine which cases should be operated upon immediately, and which should be deferred to some future time, as this depends upon the physical condition of the patient and the nature of the operation. As previously stated, if the operation is of minor character, and only a small quantity of solution is to be injected, no great amount of preparation is required. On the other hand, if the patient is in ill health, is suffering from some infection, and the nature of the operation warrants it, then the same general preparations should be carried out as though a general anesthetic were to be employed.

It is not good practice to administer a large quantity of anesthetizing solution following a full meal, or if the patient is not in a good physical condition. The operator should inject as small a quantity of the solution as possible to secure the desired results. Patients are in a very poor state of health and their resistance greatly lowered if they cannot tolerate the effects of one or two block injections. If the patient is nervous the administration of two ten-grain doses of bromural given by mouth, at intervals of twenty minutes, or seven or eight minims of camphorated validol are recommended. These drugs will diminish the patient's fear and apprehension of the operation and will in no way lower his resisting power, but rather increase it, and the patient is prepared to have the nerve blocking injections made with greater comfort and ease than when in a nervous state, as is the case many times when a preliminary sedative is not administered.

It is good practice to loosen a tight neckband, and to see that the patient's bowels and bladder are emptied before several injections are made, especially if a quantity of solution is to be injected, and considerable time will be consumed operating. The patient should be seated comfortably in the chair and be assured that there is nothing to fear. All instruments, hypodermic syringes, needles, etc., should be out of view, for the sight of these appliances will increase the patient's fear.

The operator should make a thorough examination of the part to be operated upon, and should immediately know what injection or injections should be made in order to block the area in question. The operator should not show the least hesitancy, as it must be borne in mind that even if patients know little about our professional work, they would not be oblivious of any hesitancy on the part of the operator.

Preparation of the Tissue Within the Oral Cavity.—The mucous membrane must be prepared prior to making nerve blocking injections. It is not possible to thoroughly sterilize mucous membrane or the skin, but it is possible to destroy a great many bacteria and to render the part as aseptic as possible. If the intraoral method is employed, it is good practice to spray the tissues within the oral cavity with an antiseptic, and an efficient compound is liquor antisepticus alkalinus, which, according to the U. S. P., is as follows:

		Mil or gm.
℞	Potassium bicarbonate	32 0
	Sodium benzoate	8 0
	Sodium borate	32 0
	Thymol	0 2
	Eucalyptol	0 2
	Oil of peppermint	0 2
	Methyl salicylate	0 4
	Cudbear	2 0
	Alcohol	60 0
	Glycerin	150 0
	Magnesium carbonate	10 0
	Distilled water q.s. ad	1000 0

Misce.
Sig.: Use as antiseptic in spray.

After the antiseptic has been freely employed, the mucous membrane in the region of injection should be dried, and this is best accomplished by using several pieces of sterile gauze. (See Fig. 219.) A small artery forcep is excellent for holding the gauze while removing the mucus and saliva and drying the mucous membrane.

The author has used many different germicidal solutions in preparing the mucous membrane for the needle, but has found none as efficient as equal parts of tincture of iodin and ethyl alcohol. This gives a 3½ per cent solution of iodin and minimizes the chances of sloughing of the mucous membrane. The formula is as follows:

℞	Tincture of iodin (7 per cent. U. S. P.)	30 mils.
	Ethyl alcohol	30 mils.

Misce.
Sig.: Apply to tissue on cotton applicator.

An efficient germicide which is recommended by Dr. Prinz is:

℞	Tincture of iodin (U. S. P.)	15 mils
	Acetone	30 mils

Sig.: Apply to tissue on cotton.

Equal parts of tincture of aconite and iodin are more efficient than tincture of iodin and alcohol in one respect, namely, the aconite is endowed with the power of producing slight surface anesthesia. However, the writer does not recommend the addition of aconite if a large quantity of the solution is to be applied, inasmuch as aconite if a very powerful drug, a vaso-dilator, and some patients are susceptible to it.

In addition to the powerful germicidal action that iodin possesses, it is of great advantage in preparing the oral mucosa by outlining the area of injection, because the part shows a striking contrast in color to the surrounding tissues.

The author has encountered two cases in which considerable surface sloughing was present following the application of a 3½ per cent solution of iodin, and a third case which possessed an idiosyncrasy, in which an extreme rash developed within twelve hours following its application. These cases are so rare that the operator should feel little hesitancy in applying an iodin solution of 3½ per cent strength. When we consider the germicidal medicinal preparations which would be efficient for preparing the mucosa, it is difficult to find one which fulfills the requirements as well as tincture of iodin.

Tincture of iodin is one of the most efficient germicides known to modern surgery, and when it is used on a surface containing bacteria, it will destroy them and leave the tissue in the best possible condition for repair. A dilution of 1/600 will penetrate the mucosa for considerable distance. The extra addition of alcohol is of value in reducing the standard tincture of iodin, as is given in the United States Pharmacopeia. This solution should be freely applied over a surface of two to five centimeters in diameter, by a pledget of cotton wrapped around a small applicator. (See Fig. 220.)

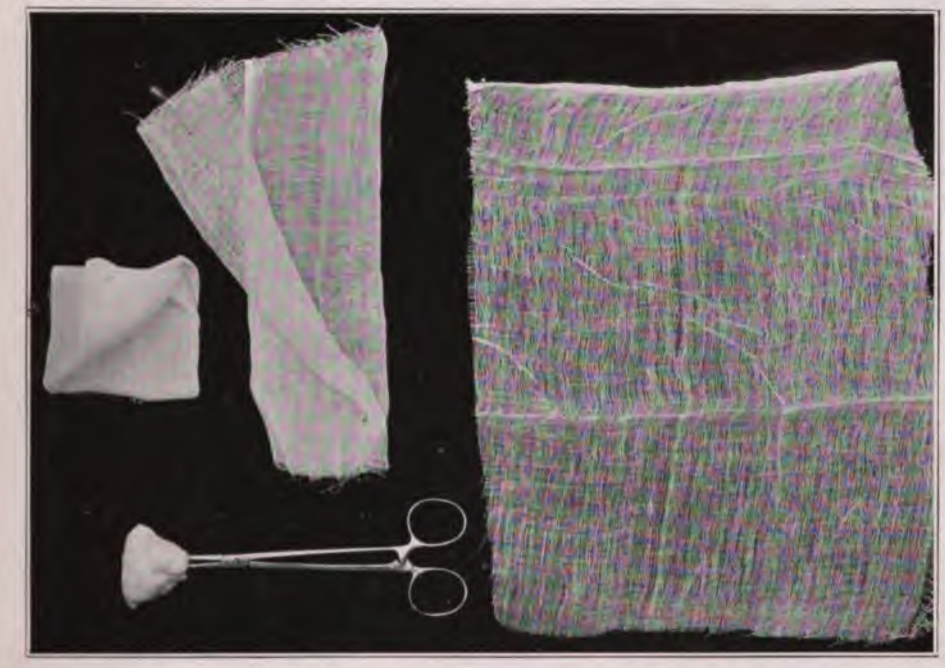


Fig. 219.—Illustrating the method of folding the gauze which is retained by artery forceps to dry the tissues.

Following the application of the germicide, care must be exercised not to permit saliva or mucus to come in contact with the surface prepared. Should the prepared part become flooded with saliva, the object of such a thorough preparation is counteracted, and there is danger of the needle carrying infected material into the deep tissues. The sterile needle should be inserted with care, not allowing it to come in contact with the teeth or tongue. If the operator observes the least resistance of the patient during the insertion of the needle, it should not be forced into the tissue any further without injecting a small quantity of the solution and waiting a few seconds before proceeding further with the needle.

Preparation of the Skin for Reception of Needle.—An area at least three centimeters in diameter should be prepared where the needle is to enter the skin. This is accomplished by first applying ether or alcohol, followed with tincture of iodin or any other efficient germicidal agent, such as 1:1000 solution of bichloride of mercury or a 2 per cent solution of lysol.

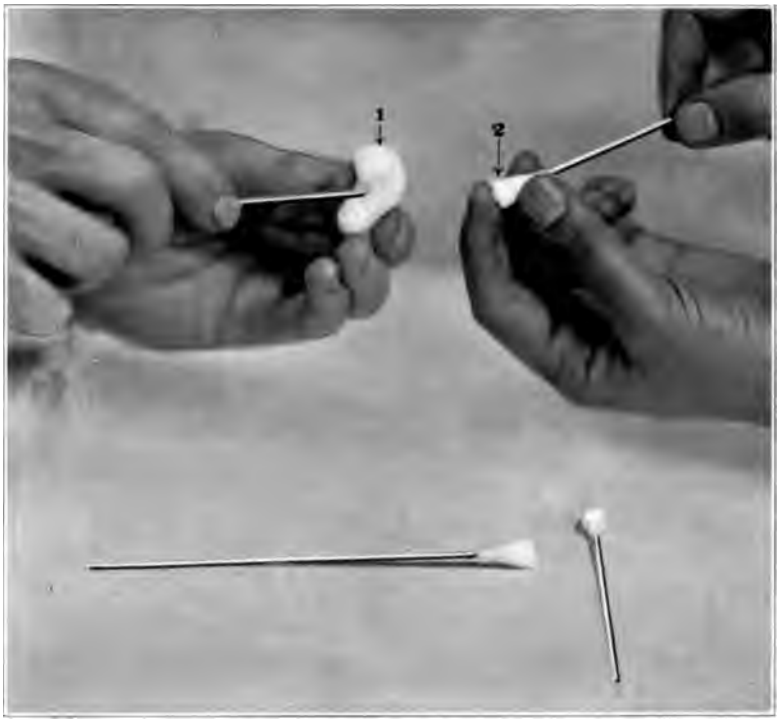


Fig. 220.—Method of wrapping cotton over end of wooden applicator in a cone-shaped fashion. *1*. Applying cotton to end of applicator; *2*, rolling cotton between thumb, first, and second fingers.

After the skin has been prepared, the next step is to make a preliminary injection. This is done by using a very fine sharp needle (28 gauge). The skin is held between the index finger and thumb and steady pressure is exerted upon it for several minutes. While the skin is being held between the index finger and thumb the small sharp needle is passed beneath the surface of the skin, holding same at an acute angle with the skin surface, while ½ mil of the solution is slowly and continuously injected as the needle enters the skin. This is called the preliminary injection. It eliminates all pain that would accompany the insertion of the regular needle through the skin for deep injection. Some operators are of the impression that severe pain is inflicted with the needle by the extraoral method, but in this they are wrong. If the preliminary injection is made by the technic previously given, little or no pain will be experienced.

After the needle passes through the skin, it enters the subcutaneous and connective tissue, muscle, fat, etc., which are almost void of any sensation. If there is pain, it is good practice to continuously inject the solution from the time the needle enters the skin until it reaches the proper depth.

Consideration and Comfort of the Patient.—The comfort and emotions of the patient must always be considered and respected before, during, and after the operation. There is a wide variation in different individuals as to their psychic and mental state and sensibility to pain. Many individuals complain very little, if at all, over factors which would cause other individuals to resist and complain bitterly. Sensibility to pain varies with age, intelligence, mental state, race, and culture. One of the most important factors the operator has to overcome is psychic fear while making a nerve blocking injection or while he is operating. The anesthetist or operator should by all means obtain the confidence of the patient before he attempts any procedure. He should observe the pulse and the physical condition of the patient, if he deems it necessary, with as little apprehension on his part as possible in order not to excite the patient. He should also talk to the patient and endeavor to divert his attention from what he is doing, and by all means encourage him while making the injection or performing the operation. The author has found it very helpful to give the patient a few inhalations of ammonia, or even a swallow of water if the operation extends over any great length of time. This seemingly unimportant step in many cases wards off an approach of nausea or a feeling of faintness, and last, but not least, psychic conditions. One should remember that when an operation under block anesthesia is being performed, the patient is aware of everything that is going on, and that all factors which may cause anxiety or nervousness of the patient should be eliminated. The application of the forceps to a tooth, or the curetting of necrosed bone, or the manipulation of retractors or sponges must be done with the utmost care.

The operator who has been accustomed to operating under nitrous oxid-oxygen anesthesia is likely, when first operating under nerve blocking anesthesia, not to be as careful in manipulating the various tissues as he should. Plenty of time should be taken while making the block injections, and the tissues should be manipulated in the gentlest possible manner. Some general surgeons give the patient a newspaper to read aloud during the operation; if the patient smokes he can be given a cigarette or cigar, and allowed to enjoy himself while the operation is being done. The object is to divert the patient's mind from what is being done, and if the operator is tactful and assuring, little difficulty is experienced in this direction.

Attempting to operate before waiting a sufficient length of time to allow the tissue to become anesthetized, has caused failure in a number of cases. It is the very beginning of the operation that demands both skill and diplomacy; in most cases the patient is on the alert and is a keen observer of what is taking place. If the operator inflicts the least pain in the beginning of the operation, it may be very difficult for him to reassure the patient that it will not occur again. The writer has observed this a number of times in the different dental offices and clinics he has visited and he wishes to lay great emphasis upon this important point. Take, for example, a circumscribed area which is to be operated upon, and which has been thoroughly blocked; if the operator is gruff and has not endeavored to secure the patient's confidence and proceeds with the operation, it is very evident he will have more difficulty than the operator who has blocked the area successfully and has obtained the confidence of his patient. The point to be emphasized is that positively no operating should be done which will cause the least amount of pain until profound anesthesia has been secured. When the operator has gained the patient's confidence, assuring him that the operation will be performed absolutely without pain, and then deliberately inflicts pain upon the patient, that patient immediately loses confidence in the operator and his skill.

Only after the area has been tested and anesthesia is pronounced should the operator proceed with the operation, always assuring the patient that no pain will be experienced. Take, for example, a nervous patient who has been blocked for the preparation of a sensitive gingival cavity, which may be so sensitive that the patient feels pain while brushing the teeth. Before placing the burr or chisel in the sensitive part of the cavity, the operator should break in the enamel walls with the chisel and at the same time, talk to the patient. We are positive there is no pain caused by cutting the enamel, and the absence of pain increases the confidence of the patient. After proceeding in this manner the operator can gently touch the deeper parts of the cavity with the bur or chisel, and if the patient shows the least sign of resistance, the operator should go no further, but stop and wait for a deeper anesthesia. If patients do not experience pain, they are in most cases very grateful, and little difficulty is encountered because they realize that the pain has been taken away, and will cooperate in every way possible to assist the operator.

Before extracting a tooth, the operator should explain to the patient that he will feel the tooth "let loose," so to speak, or that he will feel the running of the bur but no pain will be experienced. The operator should not lose sight of the fact that the patient actually feels what is taking place, and many interpret feeling as pain. The author has had a number of patients actually cry out during the extraction of a tooth, and have later informed him that they experienced no pain whatsoever, but they were afraid it was going to hurt. Most operators make the mistake of asking the patient, "Do you feel that?" Invariably the patients will say they do, and they are telling the truth because they do feel the application of the instrument, but in reality they do not feel pain. What the operator should say to them is, "I know you feel this, but it does not hurt you, does it?" This is an affirmative suggestion and tends to eliminate the patients' idea of experiencing pain. An error which the operator often makes is to extend his field of operation beyond the area which has been blocked. When this is done, the sudden pain inflicted causes the patient to resist, which may mar the successful outcome of the operation. The anesthetist or operator should converse about some matter of interest to the patient and he can remark to his assistant how nicely the operation is proceeding. The patient should never be allowed to see the hypodermic or needles before the injections are made. The assistant should have them prepared, sterile, and hand them to the operator at the proper time without being asked. The operator should always explain to his patient that the initial prick of the needle may cause the slightest pain.

Dr. Hertzler tells his patients when they ask him, that the pain can be estimated about "two mosquito power," and this is indeed a very unique way of putting it.

The reader may get the impression that the seemingly unimportant things above mentioned are not necessary, but the writer is positive that the operator or anesthetist who does not employ these tactful methods is not as successful as one who does use them. It is remarkable how far these small details go in gaining and maintaining the confidence of the patient and the successful outcome of the operation.

In making block injections with ease and accuracy, the operator must not only be familiar with the distribution and course of the nerve branch he is blocking, but must also know its relationship to other anatomic structures and the interlacing or overlapping other nerves.

Experience teaches us that the sensitiveness of various structures differs, as, for example, the skin is hypersensitive, while fat, fascia, alveolar process, bone, cartilage, muscle and tendon tissues possess little or no sensation and the synovial membrane, periosteum, peridental membrane, etc., are very sensitive. The mucous membrane of the oral cavity is not very sensitive, which is very advantageous in making intraoral block injections. As previously remarked, if the operator has been operating under a general anesthetic, it will be necessary for him to change his *modus operandi*, thereby eliminating his desire for brilliant, rapid work, and get in the habit of cultivating control, gentleness, patience and tact, and give his undivided attention to each little detail. It may be difficult for the beginner to eliminate the habit he acquired while operating under a general anesthetic. If he employs the proper armamentarium, solutions and technic he will experience no difficulty in accomplishing gratifying results from either a minor or extensive operation under nerve blocking, and his enthusiasm and success for this method will steadily increase with his experience.

Preoperative Environment.—It is imperative that the operator shall have confidence in himself before he attempts to operate, for if he is in doubt the patient will in most cases become suspicious and will naturally resist the operator, which will add to the adverse factors which may cause failure.

It was the privilege of the writer to observe two surgical operations performed under nerve blocking, and the patients were told by the surgeon that if he could not eliminate the pain through the medium of local anesthesia, he would administer ether. It was self-evident right then and there that the patients lost confidence in the surgeon and were laboring under fear and apprehension. In one of these cases the operation was performed successfully under block anesthesia, while the other was a failure, and no doubt failure was due to the fear of the patient and not ascribable to the pain inflicted. This case would, undoubtedly, have been a success had the proper psychotherapy been employed prior to operating.

Another very poor practice employed by some operators is to plug the patient's ears with cotton or to tie a towel around the ears and head so as to lessen the sense of hearing. Such a procedure has been found to result in more harm than good, because it is almost impossible to eliminate the sounds altogether, and the muffled sound of instruments and the talking of the operator tends to produce fear. It is far better to obtain the patient's confidence and assure him that he will positively not be hurt, and back it up by accuracy, competency, and thoroughness in the technic. The patient's fear of the operating room or dental office, unsoothing words, the dread of the operation, or of having an anesthetic administered, all tend to produce fear.

Numerous factors enter the preoperative treatment, and one of the most important is proper environment. The duty of the dentist by no means begins in the operating room when making an examination, but at the time the patient enters the reception room. The diplomatic operator eliminates all adverse factors through the medium of preoperative environment, and accomplishes his ideal through tactful methods. Too much emphasis cannot be placed upon the fact that the patient's mental condition must not be disturbed before the administration of any anesthetic. This is most important for local anesthesia from the fact that the patient is conscious throughout the operation.

The Value of a Preliminary Sedative.—The value of a preliminary sedative for nervous, hypersensitive patients cannot be overestimated, as it places them in a receptive mood for the anesthetic and the operation. A sedative given the patient before the operation, when indicated, has been of great value to the writer in block anesthesia and oral•surgery. The administration of a sedative to patients who are hypersensitive or hysterical, relieves them of fear or anxiety, diminishes restlessness and allays apprehension.

Dr. Hertzler calls this "the removing of hypertension from the apprehension." The author does not wish to convey the impression that a sedative is always administered prior to making nerve blocking injections, for this is far from being true, but is valuable in those individuals who are excitable and nervous.

There are a number of agents which can be employed with satisfaction, and the action and doses of these drugs have been covered in Chapters XXXV and XXXVI. Among the drugs employed, are bromural, validol, sodium and potassium bromid, and chloral hydrate. Hyoscin, morphin and cactin, or morphin with hyoscin can also be administered, but the latter named preparations are not advised unless the other sedatives fail to produce the desired results. The first-named agents do not produce as deep a sedative state as the latter; however, in certain conditions the operator may occasionally find need for the latter compounds. The writer does not advise morphin or any compound containing morphin unless its use is absolutely indicated, for several reasons: ***First***, in nearly every case, satisfactory results can be secured from sedative drugs which are not habit-forming and do not come under the Harrison Act; *second,* the after-effects are not so gratifying as when a more transient hypnotic is employed. If morphin is indicated, ⅛ to ¼ grain should be administered hypodermically one hour before the operation. In addition to the morphin, 1/150 to 1/200 grain of atropin or scopolamin can be given.

In an article written by Dr. Crile, published in *Surgery, Gynecology and Obstetrics,* 1911, page 170, he states: "Under the influence of morphin and scopolamin no one is a coward, no one is brave, every one is in a neutral state."

One of the most efficient sedatives to be used by the oral surgeon or dentist is bromural. This drug has no apparent action on the circulation or respiration, and is an agreeable hypnotic and sedative. It is best given in five grain tablets dissolved in warm water. The dosage is ten grains thirty minutes before the operation, and repeated, if necessary. The dose for children is five grains, and repeated, when necessary. It is claimed that the action of bromural ceases after from three to five hours. This drug does not produce after-effects which are often present with morphin.

Another preliminary agent of value is validol. It is a colorless substance, insoluble in water. It has a mild and pleasant odor. Validol should not be added to water before administering it. An efficient method is to drop seven or eight minims on a lump of sugar, as suggested by Dr. C. Edmund Kells. This is indeed a very unique method of administering any drug of this character, as it is very agreeable to the patient.

Nitrous oxid-oxygen analgesia is of great value in certain cases as a preliminary agent. If the operator is skillful in the administration of this valuable general anesthetic and is able to maintain a state of analgesia, it will enable him to make nerve blocking injections upon those patients in whom some preliminary agent is necessary, without waiting for a drug, such as bromural, validol or morphin and scopolamin to act. The author advises the reader to study the action of the various sedative drugs which are found elsewhere in this volume. Hypnotics should not be employed promiscuously with children.

Again, the writer does not wish to leave the impression that it is a routine procedure to administer a preliminary agent in all cases. It is very gratifying that practically all nerve blocking injections, if the technic is skillfully carried out, can be made with very little or no pain. However, if the operator deems it necessary to administer a preliminary agent, after observing the nature of the operation and the mental state of the patient, he should do so without any hesitancy.

The author advises the administration of preliminary sedatives for the following reasons:

1. A more profound anesthesia is obtained with a smaller amount of the anesthetizing solution.

2. The patient enters the operating room or takes the dental chair without fear.

3. The patient does not become nervous or excited while the operation is in progress.

Position of Patient During Block Injections.—The semi-supine position of the patient in the dental chair during block anesthesia injections is advised. (See Fig. 570.) Upon those individuals not in good physical condition, a horizontal position is even preferable to the semi-supine position. If the solution is slowly injected with the patient in the semi-supine or horizontal position, more solution can be injected, and very few cases of collapse or syncope will be encountered. The credit for first advising this position during block injections belongs to Dr. William Shearer.

Symptoms Arising During or Following an Injection.—Symptoms manifested during an injection may be either local or general. The local symptoms which may occur during an injection can be enumerated as follows:

1. Local ischemia extending into the tissue beyond the part injected. This is due to a small amount of the solution containing the vaso-constricting agent, adrenalin or synthetic suprarenin, entering a small blood vessel which contracts the small arterioles at a distant point, or it may be due to an extreme diffusion of the solution and too rapid absorption.

2. Pain may be caused by injecting a solution which is too hot or too cold. The solution should be near body temperature (98.6° F).

3. Local symptoms may be due to trauma produced at the time of injection, caused from employing a stock solution which is contaminated or one containing preservatives, such as acids, thymol, etc.

4. Local symptoms may be due to injecting the solution too rapidly.

5. Local symptoms arising during an injection may be due to the solution injected, or to its psychological effect.

6. The patient many times remarks that the part injected seems swollen or hot, this being due to the approaching anesthesia and to the presence of the solution in the tissues.

7. By injecting the solution into an abscessed or inflamed area.

General Symptoms.—Failures may be due to general symptoms developing during the injection and may be the result of one of the following factors:

1. The patient may possess an idiosyncrasy for either the vaso-constricting agent or the local anesthetic.

2. The symptoms may be due to the injection of an overamount of the solution.

3. They may be due to the toxic action of the anesthetic drug or the suprarenin.

4. The patient's face may break out with cold clammy perspiration, which may be caused by fear or the action of the solution injected.

5. The patient may experience a peculiar sensation over the entire body, and especially the extremities, this being due to the absorption of the solution injected and the effect that the suprarenin has upon blood pressure.

6. The increased blood pressure may be due to fear or to the effect of the vaso-constricting agent.

7. The patient may display symptoms of dyspnea and complain of fullness in the chest, which is due to faulty oxygenation.

8. The pulse may be rapid, which is due to fear or the toxic effect of the anesthetic drug, or the vaso-constricting agent. In many cases increased heart action is caused by apprehension and fear.

The reader is advised to read Chapter XXXVI on "Syncope, Shock and Collapse." Also toxicity of cocain, page 227, procain, page 241, and suprarenin, page 271.

CHAPTER XXIII

NAMES OF NERVE BLOCKING INJECTIONS

THE INJECTION TAKES ITS NAME FROM THE NERVE BRANCH BLOCKED

A. Ophthalmic or First Division: Deep Nerve Blocking

1. The lateral orbital injection for blocking the frontal, nasal and lachmoidal nerves.
2. Median orbital injection for blocking the anterior and posterior ethmoidal nerves.
3. Blocking the frontal nerve.
4. Blocking the supraorbital nerve.
5. Blocking the supratrochlear nerve.
6. Blocking the supraorbital and supratrochlear nerves with one injection.
7. Blocking the nerve supply of the frontal sinuses.
8. Blocking the nerve supply for operations upon the scalp, forehead and cranium.

B. Superior Maxillary or Second Division of the Fifth Cranial Nerve

9. Blocking the second or superior maxillary division of the fifth cranial nerve by the intraoral method. (Author's method.)
10. Blocking the interlacing or overlapping branches of the superior maxillary or second division of the fifth nerve.
11. Blocking the second or superior maxillary division of the fifth cranial nerve by the extraoral method.
12. Blocking the second or maxillary division of the fifth nerve by the orbital route. (Matas method.)
13. Blocking the posterior superior alveolar nerve.
14. Blocking the interlacing or overlapping branches from the posterior superior alveolar nerve.
15. Blocking the middle superior alveolar nerve by the infiltration, peripheral or terminal method.
16. Blocking the upper first molar by the infiltration or terminal method.
17. Blocking the upper first bicuspid by the terminal or infiltration method.
18. Blocking the upper second bicuspid by the terminal or infiltration method.
19. Blocking the middle superior alveolar nerve which supplies the two

superior bicuspids and first molar, alveolar process and buccal structures by the intraosseous method.

20. Blocking the interlacing or overlapping branches connecting with the middle superior dental nerve by the intraosseous method.

21. Blocking the middle superior alveolar nerve for the upper first molar by the intraosseous method.

22. Blocking the middle superior alveolar nerve for the upper first bicuspid by the intraosseous method.

23. Blocking the middle superior alveolar nerve for the upper second bicuspid by the intraosseous method.

24. Blocking the infraorbital nerve and terminal branches and the anterior superior alveolar nerve.

25. Blocking the interlacing or overlapping branches in the infraorbital region.

26. Blocking the interlacing or overlapping branches of the anterior superior alveolar nerve by combined infraorbital and intraosseous injections.

27. Blocking the anterior superior alveolar nerve by the insufflation method.

28. Blocking the anterior superior alveolar nerve for the upper cuspid by the infiltration, terminal or subperiosteal method.

29. Blocking the anterior superior alveolar nerve for the upper lateral incisor by the terminal, infiltration or subperiosteal method.

30. Blocking the anterior superior alveolar nerve for the upper central incisor by the terminal, infiltration or subperiosteal method.

31. Blocking the anterior and middle superior alveolar nerves for the upper cuspid lateral and first bicuspid teeth by the terminal, infiltration or subperiosteal method.

32. Blocking the anterior and middle superior alveolar nerves for the central, lateral, cuspid, first and second bicuspid teeth by the terminal, infiltration or subperiosteal method.

33. Blocking the right and left anterior superior alveolar nerves for the upper central incisor by the terminal, infiltration or subperiosteal method.

34. Blocking the right and left anterior superior alveolar nerves for the upper centrals and laterals by the terminal, infiltration or subperiosteal method.

35. Blocking the right and left anterior superior alveolar nerves for the upper six anterior teeth by the terminal, infiltration or subperiosteal method.

36. Blocking the anterior superior alveolar nerve for the upper cuspid, lateral and central incisor teeth by the intraosseous method.

37. Blocking the upper right and left anterior superior alveolar nerves for the upper six anterior teeth by a single intraosseous injection.

38. Blocking the right and left anterior superior alveolar nerves for the upper six anterior teeth by two intraosseous injections.

39. Blocking the anterior superior alveolar, infraorbital nerve and its terminal branches by the extraoral method.

40. Blocking the interlacing or overlapping branches of the infraorbital nerve and anterior superior alveolar nerve by an extraoral infraorbital injection.

41. Blocking the right or left region of the superior maxillary bone and other tissues.

42. Blocking the anterior palatine nerve at the posterior palatine foramen.

43. Blocking the interlacing or overlapping branches of the anterior palatine nerve.

44. Blocking the anterior palatine nerve anterior to the posterior palatine foramen, such as lingual to the upper first and second bicuspids, first, second, and third molars.

45. Blocking the lingual nerve supply to the upper cuspid, by injecting the solution lingual to the apex.

46. Blocking the nasopalatine nerves at the anterior palatine foramen.

47. Blocking the tissues lingual to the upper six anterior teeth.

48. Blocking the nasopalatine nerve to the lingual of the central incisor.

49. Blocking the nasopalatine nerve to the lingual of the central and lateral incisor teeth.

50. Blocking the terminal or overlapping branches of the naso and anterior palatine nerve lingual to the upper cuspid tooth.

51. Blocking the upper sixteen teeth, alveolar process, buccal and labial structures with two intraoral second division injections and two intraosseous injections.

52. Blocking the upper jaw, including all the teeth, alveolar process and bone; including both the inner and outer nerve loops by a right and a left intraoral, second division injection.

53. Blocking the right and left posterior superior alveolar nerves in conjunction with intraosseous anesthesia.

54. Blocking a single tooth by the intraosseous method.

55. Blocking various areas by the intraosseous method.

C. The Mandibular or Third Division of Fifth Cranial Nerve

56. Blocking the mandibular or third division of the fifth nerve by the extraoral method.

57. Blocking the interlacing or overlapping branches following an extraoral third division injection.

58. Blocking the inferior dento-lingual nerves by the intraoral method.

59. Blocking the inferior dental nerve separately from the lingual nerve by intraoral method.

60. Blocking the lingual nerve separately from the inferior dental nerve by intraoral method.

61. Blocking the interlacing or overlapping branches following the inferior dento-lingual blocking.

62. Blocking the inferior dento-lingual nerves in children.

63. Blocking the inferior dento-lingual nerves by the extraoral route.

64. Blocking the long buccal or buccinator nerve buccal to the lower second and third molars.

65. Blocking the long buccal or buccinator nerve to the posterior and inferior of the opening of Stenson's duct.

66. Blocking the mental and incisive nerves at the mental foramen by the intraoral route.

67. Blocking the mental and incisive nerves by the extraoral route.

68. Blocking the soft tissues within the oral cavity by the circular or regional method.

69. Blocking the tissues by the submucous method.

70. Blocking the tissues by the subperiosteal method.

71. Blocking a single tooth by the subperiosteal method by holding the needle parallel to the long axis of the tooth.

72. Blocking the tissues by the subperiosteal method by holding the needle parallel to the occlusal plane of the tooth.

73. Blocking the lingual nerve supply in the region of the two lower bicuspid teeth.

74. Blocking the lingual nerve branches situated to the lingual of the four lower incisor teeth.

75. Blocking the ten lower anterior teeth for exodontia or other surgical operations which involve the lingual structures.

76. Blocking the ten lower anterior teeth for dental operations not involving the lingual structures.

77. Blocking the lower central, lateral, cuspid, first and second bicuspid teeth for dental operations not involving the lingual structures.

78. Blocking the lower central, lateral, cuspid, first and second bicuspid teeth for exodontia or other surgical operations including the lingual structures.

79. Blocking the lower cuspid tooth for operative dentistry.

80. Blocking the lower cuspid for exodontia or surgery.

81. Blocking the region of the lower teeth on the entire side, across the median line including all teeth, buccal and lingual tissues, from the lower third molar to the lower second bicuspid on the opposite side.

82. Blocking the lower sixteen teeth, alveolar process, a portion of the lower jaw, buccal, labial and lingual structures.

83. Blocking the incisive nerve.

84. Blocking the interlacing or overlapping branches accompanying the incisive injection.

85. Unilateral blocking to median line using incisive injection.

D. Blocking for Various Operations

86. Blocking for operations upon the cranium, dura mater, and brain.

87. Blocking for tonsillectomy. (Author's deep block method.)

88. Blocking the nerve supply of the superior maxillary bone for maxillary sinus operations by the extraoral method.

89. Blocking the nerve supply of the superior maxillary bone for maxillary sinus operations for the intranasal method of operating.

90. Blocking the lower cuspid for exodontia or surgery.

91. Blocking the second division of the fifth nerve by the extraoral method for maxillary sinus operations.

92. Blocking the upper jaw by combining the second division with the infraorbital injection.

93. Blocking the nerve supply for the resection of the superior maxillary bone.

94. Blocking the nerve supply for apicoectomy.

95. Blocking the nerve supply for alveolectomy.

96. Blocking the nerve supply for operations situated in the soft tissues forming the floor of the mouth.

97. Blocking the nerve supply for surgical operations upon the lower jaw.

98. Blocking the nerve supply for operations upon the tongue.

99. Blocking the nerve supply for operating various tumors situated upon the face or within the oral cavity.

100. Blocking the Gasserian ganglion in treatment of tic douloureux.

101. Blocking the Gasserian ganglion for major operations.

102. Blocking the sphenopalatine ganglion for tic douloureux.

103. Blocking the infraorbital nerve and facial branches for harelip operation in adult.

104. Blocking the nerve supply for cleft palate operation in adult.

105. Blocking the nerve supply for goiter operations.

106. Blocking the nerve supply for fractures of the jaws.

107. Blocking the nerve supply for plastic surgery of the face.

108. Blocking the cervical plexus for goiter operations.

109. Blocking the nerve supply for operations upon and within the ear.

110. Blocking the small occipital nerve.

111. Blocking the great occipital nerve.

112. Blocking the auriculotemporal nerve.

113. Blocking the pharyngeal plexus for tonsillectomy.

114. Blocking the tonsillar plexus for tonsillectomy.

115. Blocking the anterior, middle and posterior palatine branches of Meckel's ganglion for tonsillectomy.

116. Blocking the superior laryngeal nerve.

117. Blocking the glossopharyngeal nerve.

E. Miscellaneous Methods

118. Terminal, peripheral or infiltration method.
119. Schleich's infiltration method.
120. Blocking the terminal or peripheral nerves by the peridental method.
121. Pressure anesthesia.
122. High pressure anesthesia.
123. Circular or regional method of anesthesia by the intra- and extraoral methods.
124. Intravenous method of producing anesthesia.
125. Intraarterial method of producing anesthesia.
126. Spinal anesthesia.

CHAPTER XXIV

BLOCKING THE BRANCHES OF THE FIRST OR OPHTHALMIC DIVISION OF THE FIFTH NERVE

The anatomy of this nerve branch has already been covered in Chapter VII. Branches of the ophthalmic division which supply the contents of the orbit and forehead with sensation can easily be blocked. In addition to blocking the branches of the ophthalmic divisions, such as the supraorbital and supratrochlear, the operative field should be circuminjected for operations upon the scalp and forehead. The ophthalmic division divides into three branches, which are the frontal, lachrymal and nasociliary; therefore, its branches are blocked instead of the ophthalmic division itself.

The blocking of the supraorbital and supratrochlear branches, as they pass out of the orbit over the supraorbital margin, is given on page 743; therefore, the deep block injections in the orbital cavity itself will be discussed. At this time it is very essential for the reader to familiarize himself with the osteology of the orbit, which is given on page 408. The nasociliary branch of the ophthalmic division enters the orbit through its apex and innervates the eye. It also gives off two branches which are called the anterior and posterior ethmoidal, which pass into their respective foramina. The other two large divisions of the ophthalmic are the lachrymal and frontal, which are given off outside the apex of the orbit. The surface of bone which makes up the orbit in the region of these branches is very suitable for deep block injections, inasmuch as the wall of the orbit is an excellent guide in directing the needle toward the apex of the orbit by forcing the needle backward in constant contact with the periosteum covering the bone. The lateral wall and the superior portion of the median wall is very smooth and is practically straight, which, as previously stated, is excellent for guiding the needle into its proper location. While inserting the needle, the point should always be kept in contact with the bone, and if this is done, there will be no danger of injuring any of the contents of the orbital cavity. The nerves of the ophthalmic division are blocked by a lateral and median orbital injection.

THE LATERAL ORBITAL INJECTION. BLOCKING THE FRONTAL AND LACHRYMAL NERVES (BRAUN ROUTE)

After the skin has been aseptically treated and a preliminary injection is made, the skin is punctured at a point two millimeters above the external canthus of the eye with the deep block needle, which is twenty-two gauge and sixty millimeters long. (See Fig. 221.) The puncture point is situated near the suture formed by the junction of the malar and frontal bone. The point of the needle strikes the periosteum on the medial surface of the rounded bone which forms the lateral orbital margin, and it should be kept in close contact with the periosteum. The needle is held in a horizontal position until its point strikes the periosteum covering the medial surface of the lateral orbital margin, and then it is directed toward the median line following the periosteum, and it should assume an angle of about 45 degrees toward the median line. As the needle is forced backward and slightly downward along the lateral wall of the orbit to an approximate depth of three and a half centimeters, the needle point will encounter the distal border of the superior orbital fissure (sphenoidal) in the superior wall of the orbit which will prevent the needle from being inserted further posteriorly. (See Fig. 223.) This bone, which is struck by the point of the needle, is the outer end of the superior orbital fissure which in most cases will prevent the needle from passing posteriorly; however, if the superior orbital fissure is very large, there is some danger of the needle entering the cranial cavity if it is forced too far distally.

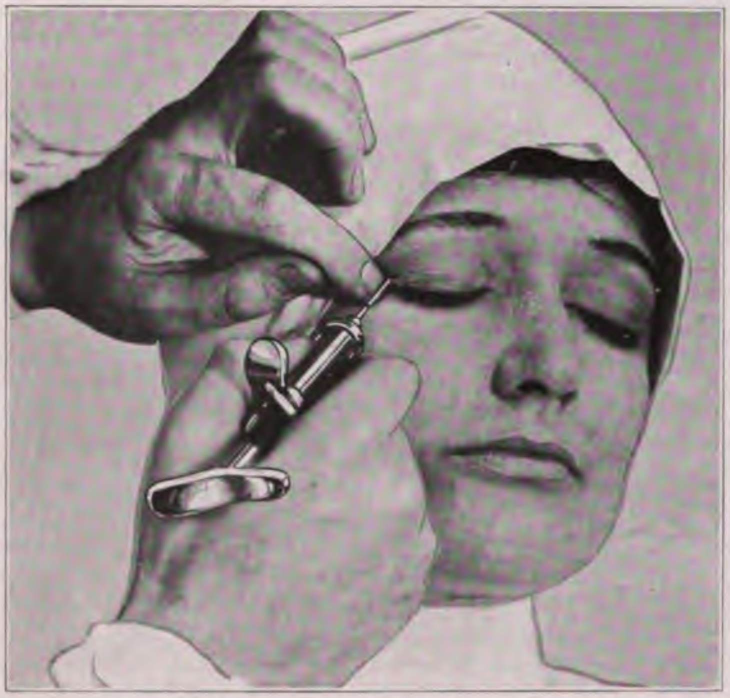


Fig. 221.—The lateral orbital injection. The needle is inserted into the skin at a point two millimeters above the external canthus of the eye. (See Fig. 222 for position of needle during injection.)

According to Allen, the distance between the lateral portion of the superior orbital fissure and the lateral orbital margin varies from 27 to 40 mm. the average being 33.5 mm. If the needle assumes an upward direction, the point will strike the lesser wing of the sphenoid bone and would be in close contact with the optic nerve; therefore, great care should be taken in directing the needle slightly downward from the puncture point.

Average Depth of Needle.—In summing up the above measurements, the author advises that the needle should, in the average case, be inserted only to a depth of 3 cm. for the purpose of producing block anesthesia.

Amount of Solution Injected.—Three mils of a 2 per cent procain suprarenin Ringer solution is slowly injected, and it is well to work the needle back and forth through a distance of 2 or 3 mm. while injecting the solution.

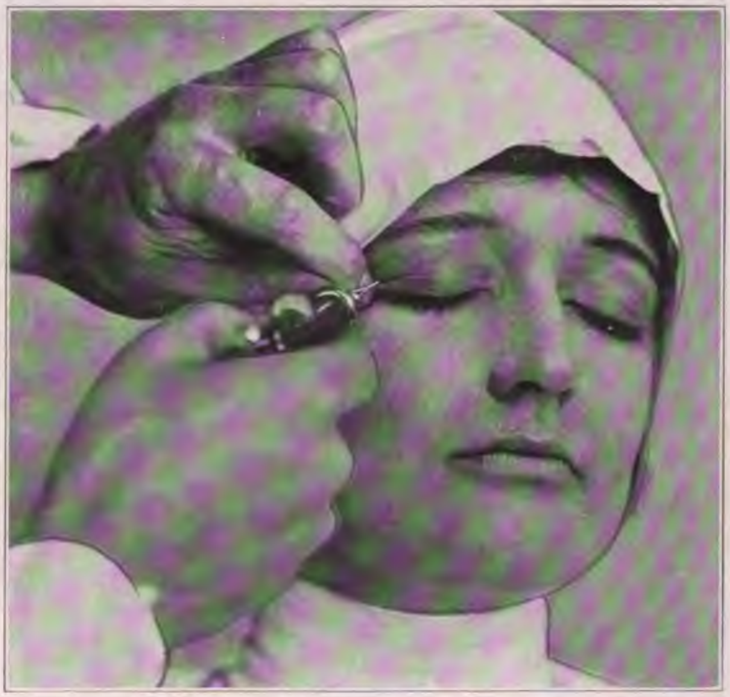


Fig. 222.—The lateral orbital injection. Illustrating position of the needle during injection.

Structures Anesthetized.—This injection blocks the lachrymal and frontal nerves and is sufficient for operations on the orbit or frontal sinus. Attention is called to the fact that the frontal nerve divides into the supraorbital and supratrochlear branches, and in case this deep injection is made, it is not necessary to inject the latter named nerves, as they pass over the supraorbital margin. The frontal nerve is blocked before the supraorbital and supratrochlear branches are given off.

Time to Wait For Anesthesia.—A profound anesthesia is obtained in from five to ten minutes.

MEDIAN ORBITAL INJECTION FOR BLOCKING THE ANTERIOR AND POSTERIOR ETHMOIDAL NERVES (PEUCKART ROUTE)

This deep injection, which is made on the median side of the orbit, blocks the ethmoidal nerve branches which supply the sphenoidal and frontal sinuses and mucous membrane of the cribriform plate of the ethmoid bone. Branches are also distributed to the cartilage and skin of the tip of the nose. Branches also supply the superior and anterior parts of the nasal mucous membrane with sensation.

Before covering the technic, the necessary landmarks will be given. If a horizontal line is drawn along the inner wall of the orbital cavity extending from the optic foramen to the root of the nose, it will be found that this line passes through the anterior and posterior ethmoidal foramina. The reader at this point should refer to the osteology of the orbital cavity which has been given on page 408.

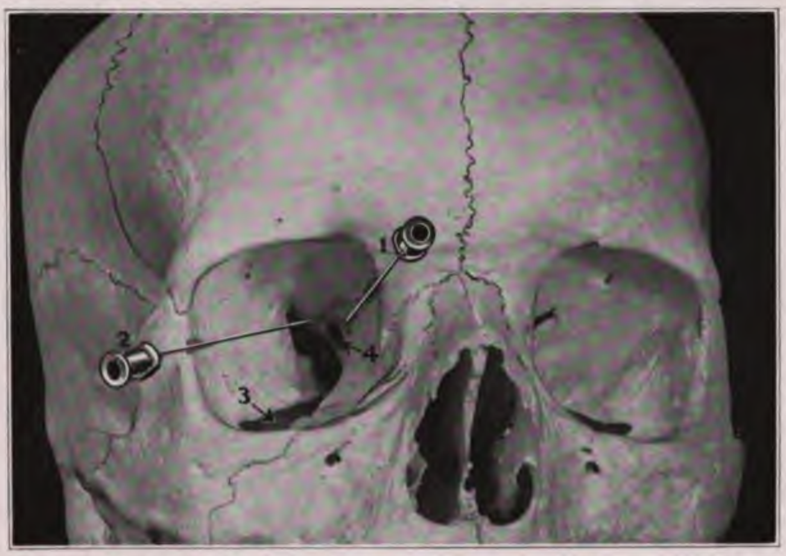


Fig. 223.—Position of needles for the lateral and medial orbital injections.
1, needle for medial orbital; 2, needle for lateral orbital; 3, inferior orbital fissure; 4, optic foramen.

Technic for Median Orbital Injection.—The technic for the median orbital injection is as follows: After treating the skin aseptically, a small quantity of the anesthetic solution is injected into the skin at the point of puncture, thereby producing a wheal. The nerve blocking needle is now employed, which is 22 gauge, and 60 mm. long. The puncture point is located on a level with the root of the nose, and the needle is in contact with the periosteum covering the inner orbital margin. The needle is forced through the skin, striking the inner orbital margin, holding the needle in both a sagittal and horizontal plane. It is now forced backward along the inner wall of the orbit at the junction of the upper and inner walls, care being taken to keep the point of the needle in contact with the periosteum.

Amount of Solution Injected.—The approximate distance between the inner orbital margin and the anterior ethmoidal foramen is 2 cm., and at this point two mils of a two per cent procain suprarenin Ringer solution is injected.

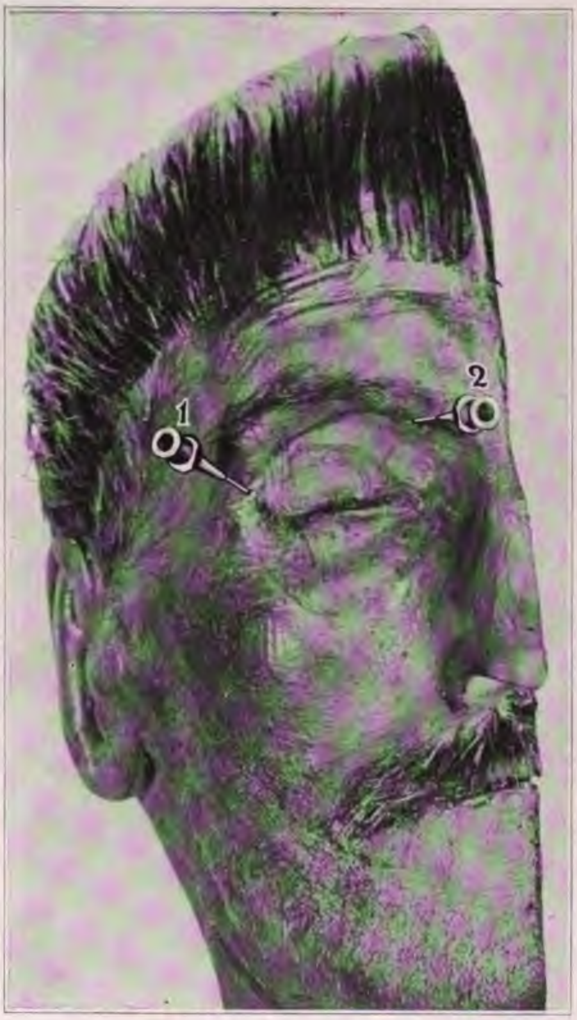


Fig. 224.—Lateral and medial orbital injections.
1, lateral orbital; 2, medial orbital.

Structures Anesthetized.—The blocking of the anterior ethmoidal nerve will anesthetize the mucous membrane lining the anterior and superior parts of the nasal fossa; nasal septum; anterior inferior part of the nose; anterior half of middle meatus and turbinate bone; anterior half of the inferior meatus and turbinate bone; anterior lateral part of wall of nasal fossa; anterior ethmoidal cells; and frontal sinus. If the reader will refer to the description of the anterior ethmoidal nerve, as is found on page 84, he will see this nerve gives off an intranasal section which is again divided into external and internal branches which are blocked by this injection as set forth above.

Time to Wait for Anesthesia.—The time to wait for anesthesia following injection varies from five to ten minutes.

Blocking the Posterior Ethmoidal Nerve.—After injecting the solution to block the anterior ethmoidal nerve, if it is desired to also block the posterior ethmoidal nerve, the needle is now forced 1½ cm. farther posteriorly along the medial wall of the orbit. The average distance between the anterior and posterior ethmoidal nerves, as they pass out of their respective foramina, is one and a half centimeters; the distance from the inner orbital margin to the anterior ethmoidal nerve is 2 cm., and the distance between the two foramina is approximately 1½ cm.: therefore, the total distance which the needle is inserted to block the posterior ethmoidal nerve is 3½ cm.

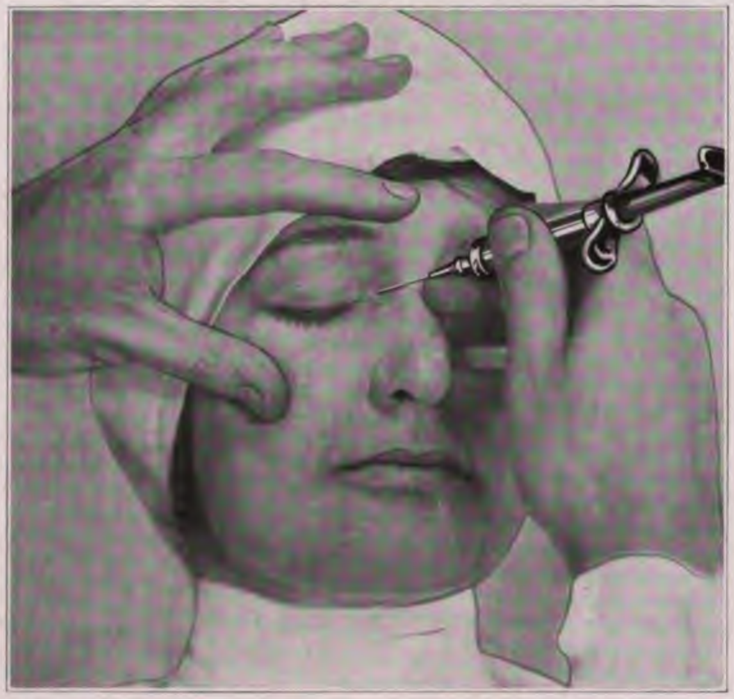


Fig. 225.—The medial orbital injection. The skin is punctured on a level of the root of the nose.

Amount of Solution Injected.—The amount of solution injected for blocking the posterior ethmoidal nerve is two mils.

Time to Wait for Anesthesia and Structures Anesthetized.—Anesthesia is produced in from five to ten minutes in the mucous membrane of the sphenoidal sinus and posterior ethmoidal cells.

Great care should be exercised not to insert the needle too far posteriorly in view of the fact that the optic nerve, as it emerges from the cranial cavity through the optic foramen, is on a direct line with the needle. The average distance between the optic nerve as it enters the orbital cavity through the optic foramen and the inner orbital margin is 4 cm. The needle should not be inserted to a greater depth than 3 cm. so as to make sure that it does not enter the region of the optic nerve. The posterior ethmoidal foramen is located from 3½ to 4 cm. from the inner orbital margin, but inasmuch as it might prove a dangerous procedure to insert the needle into the region of the optic nerve as it passes out of the optic foramen, it is, therefore, advisable to make the maximum depth 3 cm. Even if the injection is made anterior to the posterior ethmoidal foramen, the solution will reach the posterior ethmoidal nerve by infiltration and will produce the desired result. The amount of solution injected, as set forth above, is two mils, and if deposited from 5 to 8 mm. anterior to the location of the nerve, the solution will infiltrate through the orbital tissues, thereby reaching the nerve itself.

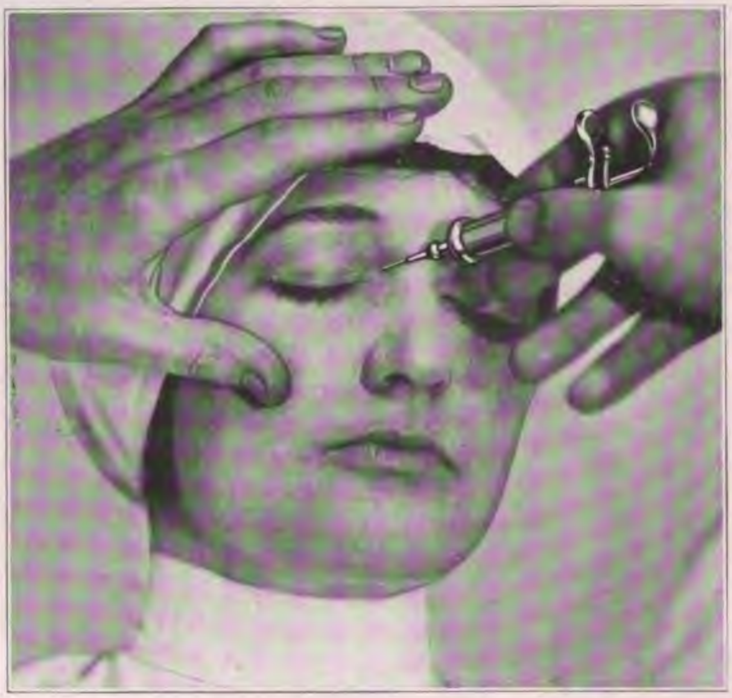


Fig. 226.—The medial orbital injection. The needle is extended backward along the inner wall of the orbit and illustrates the correct position during injection.

Following the medial or lateral orbital injections a small hematoma may occasionally occur in the connective tissue and fat which are located in the region where the solution is deposited. The injecting solution should not contain more than 1/3,200 of a grain of suprarenin per mil, because the vaso-constriction may produce anemia of the optic nerve. The anesthetic content itself will act upon the optic nerve, but its effects are only transient.

Jassenetcky reported a case of amaurosis, which was temporary in character, following a block injection for empyema of the frontal sinus. However, he attributed the condition to inflammatory edema and infection, and believed the injection itself had nothing to do with the inflammation.

CHAPTER XXV

TECHNIC FOR BLOCKING THE SECOND DIVISION OF FIFTH NERVE AND ITS BRANCHES

BLOCKING THE SUPERIOR MAXILLARY OR SECOND DIVISION OF THE FIFTH CRANIAL NERVE

There are three methods or routes employed for blocking this large nerve trunk, which are: 1. Intraoral. 2. Extraoral. 3. Orbital.

The author will not endeavor to describe here the detailed anatomy of this nerve trunk and its relationship to other structures, but he refers the reader to Chapter VII on the "Nervus Trigeminus." However, it is very essential at this time to repeat some of the most important points relative to this large nerve trunk.

The nervus maxillaris, or second division, passes anteriorly, slightly inferiorly and laterally, from the Gasserian ganglion through the middle fossa of the skull within the cranial cavity, making its exit through the foramen rotundum, which is located in the greater wing of the sphenoid bone. (See Figs. 40, 41, 42, 48, 49, 51, 60, 61.) This nerve is situated outside the dura mater and is composed entirely of sensory nerve fibers. After it emerges from the foramen rotundum it enters the pterygoid fossa. (See Figs. 64 and 65.) After it traverses the superior part of this fossa, it takes a lateral course and forms a slight curve, then it enters the sphenomaxillary fossa, and after passing through this fossa, it passes anteriorly and slightly laterally, entering the sphenomaxillary fissure (inferior orbital fissure) which is situated in the posterior inferior floor of the orbit. It enters the orbit through the infraorbital fissure, at which place it receives the name of infraorbital nerve. (See Figs. 40, 42, 49, 51.) After traversing the infraorbital fissure, it enters the infraorbital groove and canal, later making its exit upon the face through the infraorbital foramen. (See illustrations 32, 40, 69, 70, 74.)

BLOCKING THE SECOND OR SUPERIOR MAXILLARY DIVISION OF THE FIFTH CRANIAL NERVE BY THE INTRAORAL METHOD

Author's Method.—In 1913 the writer began to experiment with a method for blocking the second division of the fifth nerve, and he now presents such a technic by the intraoral route. It has been carefully worked out from dissections of a large number of cadavers. Numerous injections were made on cadavers, using a solution of methylene blue. Following these dissections, the technic was carefully evolved and numerous injections were made upon patients before the technic was presented to the profession.

The blocking of the second division of the fifth nerve by the intraoral route is now employed with satisfaction by many operators, thereby eliminating several injections which are otherwise required to block the same area. This injection is not only of great value to the oral surgeon and dentist, but to the eye, ear, nose, and throat specialist. The blocking of this large nerve trunk is easily accomplished, in fact, it is no more difficult than the inferior dental, lingual, or some of the other intraoral block injections.

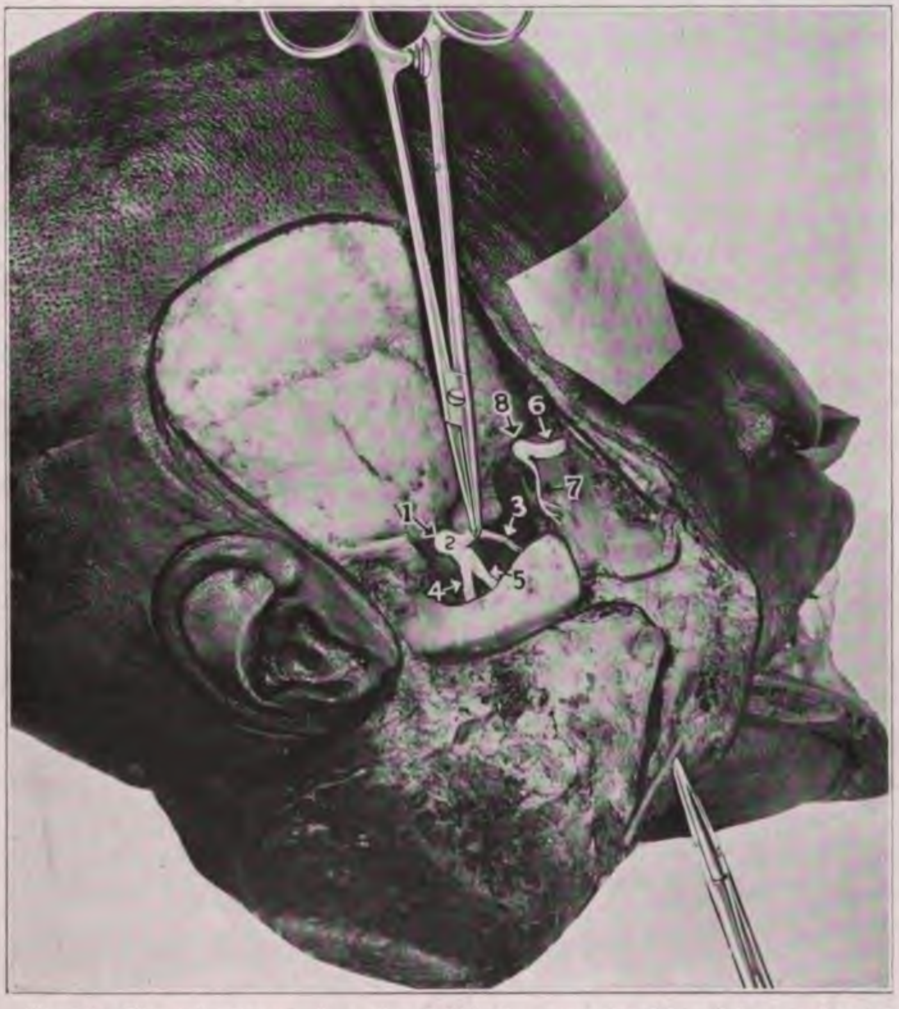


Fig. 227.—Dissected wet anatomic specimen which shows normal position of the second and third divisions of fifth nerve.

1, Foramen ovale; 2, mandibular nerve; 3, long buccal nerve; 4, inferior dental nerve; 5, lingual nerve; 6, second division or superior maxillary nerve; 7, posterior superior dental nerve; 8, foramen rotundum.

The osteology and nervous anatomy of the superior maxillary or second division have already been described in Chapter VII on the Nervus Trigeminus. Before the operator attempts this injection, he should master the anatomy, and when he has done so, the technic can be easily applied with gratifying results.

Needle Employed.—The needle and extension used for this injection is of special design. The extension has sufficient curve to allow the needle to come in contact with the periosteum covering the lateral aspect of the tuberosity of the superior maxillary bone when the hub of the extension is held midway between the occlusal planes of the upper and lower teeth. The needle is made of iridio-platinum, is 40 millimeters long, and 22 gauge. The bevel is located on the side of the extension hub. (See Fig. 177 needle No. 6.)

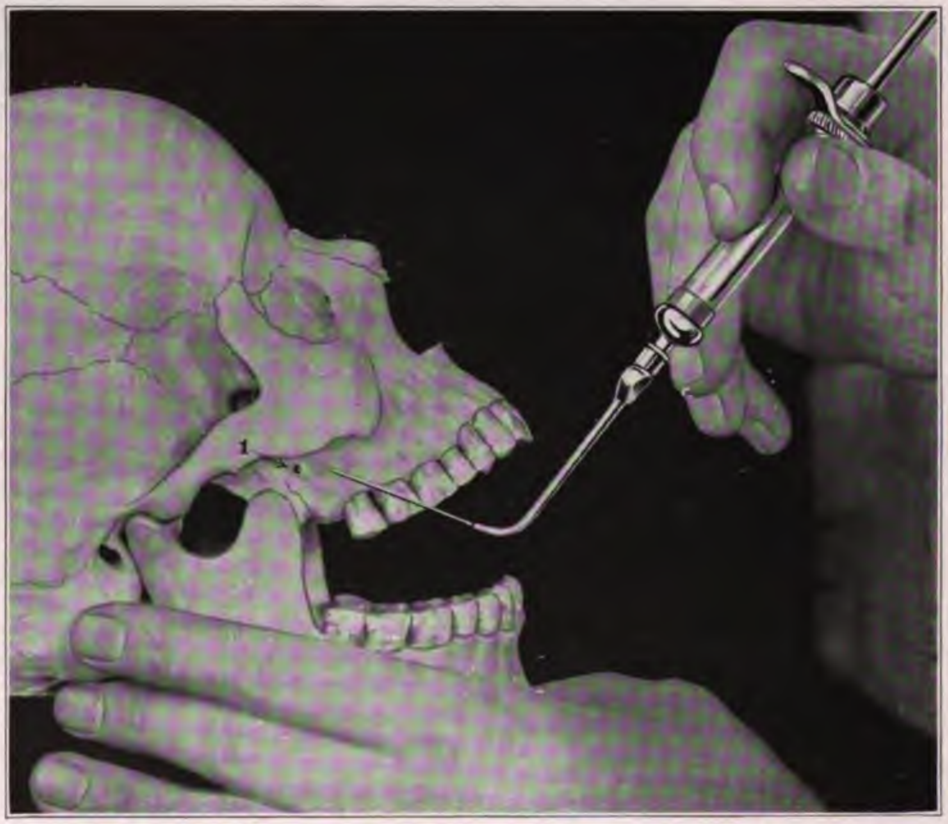


Fig. 228.—Illustrating the point of the needle which is located 1 centimeter buccal to the alveolar plate of third molar just after the needle enters the mucous membrane. 1, posterior superior dental foramen.

Technic of Injection.—The buccal and occlusal surfaces of the upper second and third molars, gum tissue, mucous membrane, and cheek in the region of the upper second and third molar are thoroughly prepared for the needle by drying and applying the germicidal solution. An area at least 3 cm. in diameter should be thoroughly prepared. The syringe should contain 4 c.c. of the anesthetizing solution and should be held in the hand pen fashion. The operator should stand in front of his patient with the patient assuming the semisupine position. The patient's mouth should be half open to allow the operator to extend the cheek laterally with the first and second fingers to expose the area for the needle. The next step is to puncture the mucous membrane between the gum tissue and inner side of the cheek. (See Figs. 228, 229 and 230.) In other words, the highest point in this region. The needle should enter the mucous tissue above and to the buccal of the apices of the roots of the upper third molar. Great care should be taken not to insert the needle too near the gum tissue, for such a procedure would make it impossible to carry the needle in the right direction. In case the needle is started in the gum tissue, it will not follow the periosteum covering the posterior lateral surface of the tuberosity of the superior maxillary bone. After puncturing the tissue in the manner described the needle is advanced upward, inward and slightly backward into the mucous membrane allowing the bevel of the needle to reach the periosteum covering the lateral surface of tuberosity at approximate depth of 15 mm. After

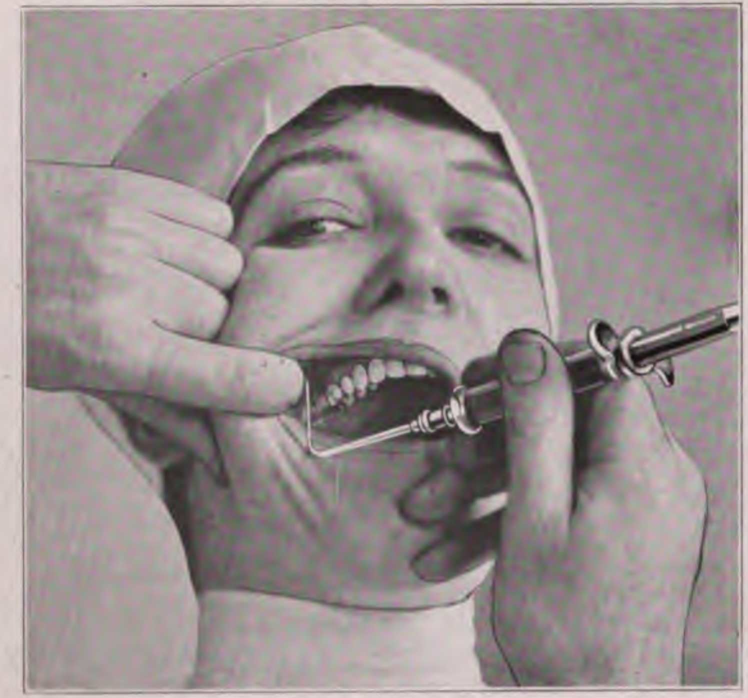


Fig. 229.—The needle is being advanced into the mucous membrane from the puncture point which is located in the reflection of mucous membrane buccal to upper third molar. Needle is advanced upward, slightly backward and inward. When a depth of 15 millimeters has been reached, the needle point should be in contact with the periosteum covering the lateral portion of tuberosity. After the periosteum has been reached, the needle is advanced inward and upward an additional 15 millimeters along the periosteum making a total depth of 30 millimeters which is the approximate depth to block the second or superior maxillary division of fifth nerve.

the needle reaches the periosteum at this depth, the needle is advanced in close contact with the periosteum covering the posterio-lateral surface of the tuberosity, approximately 15 mm. making a total depth of 30 mm. (See Figs. 231, 235, 236.) The extension and hub should assume a position midway between

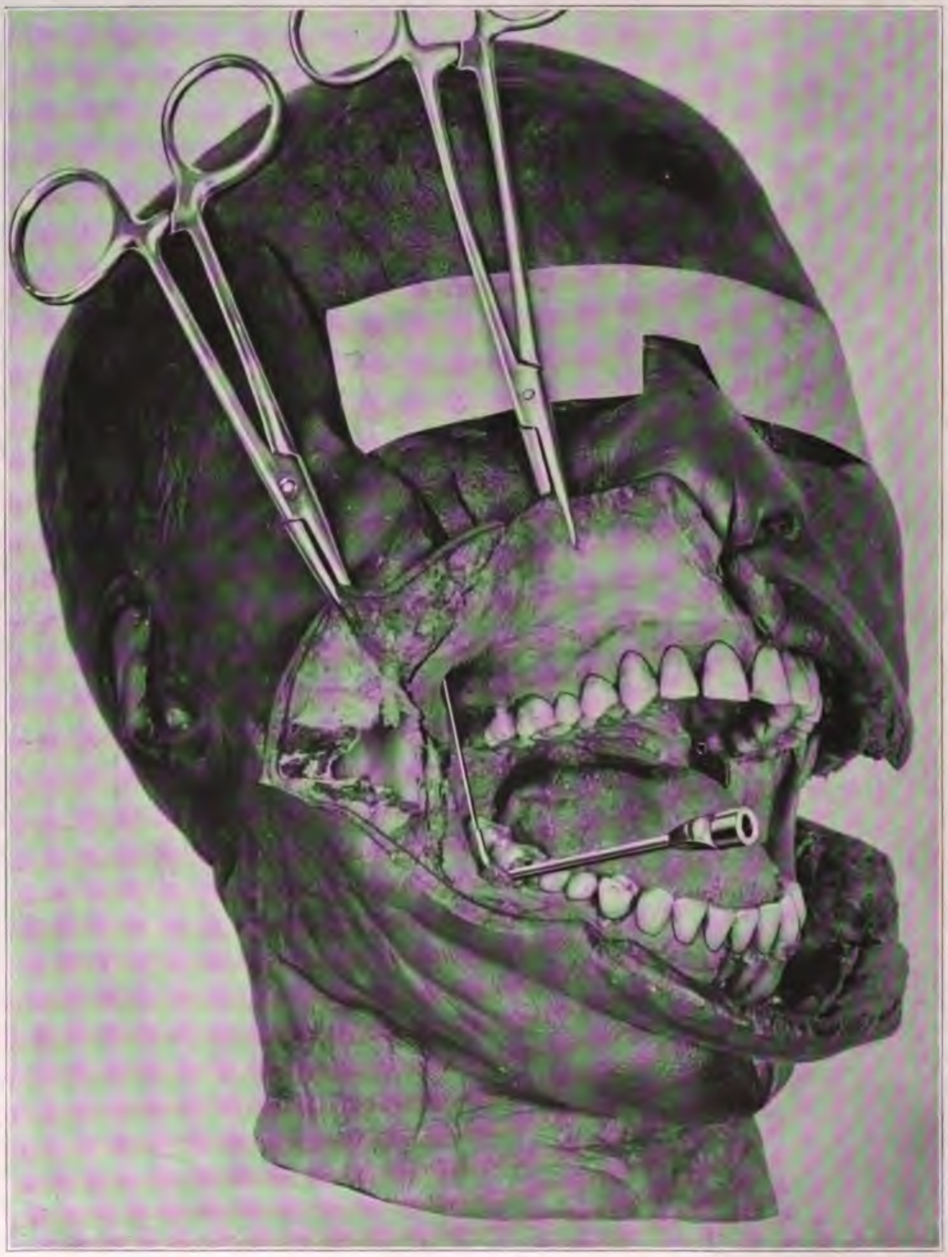


Fig. 230.—Illustrating the first position of the needle for blocking the second division of the fifth nerve by the intraoral method. The point of puncture is located in the reflection of mucous membrane situated between the cheek and gum tissue—buccal to the upper third molar.

the occlusal planes of the upper and lower teeth. (See Figs. 232, 233, 234.) The lateral part of the hub and extension should be on a line drawn from the buccal surface of the upper bicuspids to the buccal surface of the lower bicuspids. Force the needle into the mucous membrane as described until approximately 3 cm. of the needle have disappeared. After considerable experience upon patients and cadavers, the writer has found the distance from the puncture point, as mentioned, to the second division of the fifth nerve as it crosses the sphenomaxillary fossa, is from 27 to 33 mm., the average being 30 mm. or 3 cm. During the insertion of the needle great care should be exercised in NOT allowing it to assume a perpendicular course, for if such is the case the needle will not remain in contact with the periosteum covering the tuber maxillare. If the extension hub is held parallel to the occlusal plane of the upper teeth while the needle is being inserted, the needle point will strike the inferior lateral portion of the greater wing of the sphenoid bone, or the lateral portion of the external pterygoid plate. If this has been done, the needle should be withdrawn and the correct technic employed. In case the needle has been incorrectly directed too far posteriorly, care should be taken to withdraw it from the tissue before depressing the extension hub. Such a procedure would cause the needle to bend at the soldered joint, as considerable leverage is exerted on the needle by the syringe. The route followed by the needle is void of large arteries, veins, and nerves. As the needle

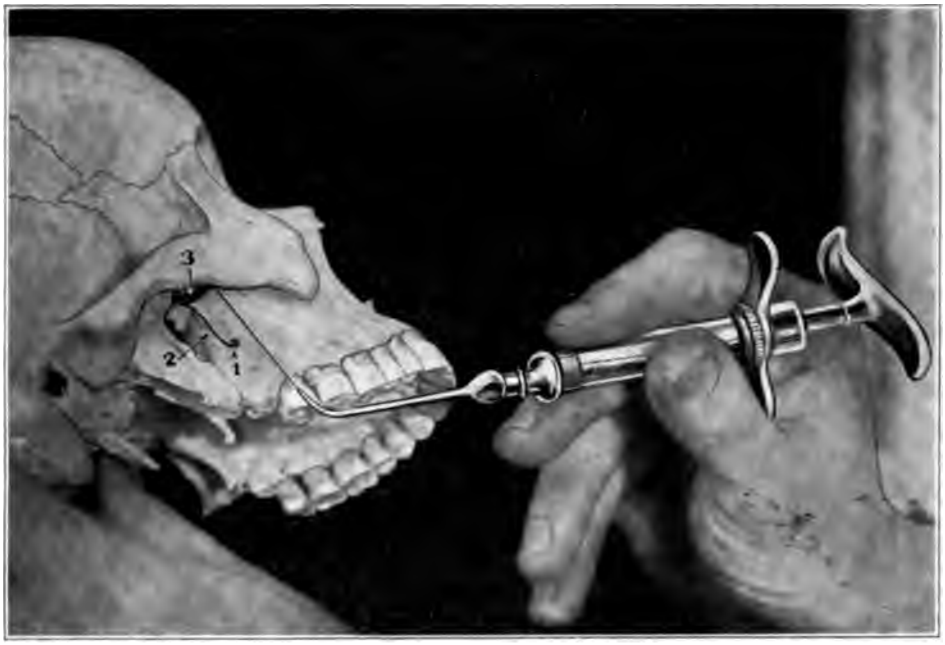


Fig. 231.—The needle located lateral to the tuberosity and third molar also anteriolateral to posterior superior dental nerve and foramen.

1, posterior superior dental foramen; 2, posterior superior dental nerve; 3, second division of the fifth nerve crossing the sphenomaxillary fossa.

passes along the periosteum covering the posterior lateral tuberosity of the superior maxillary bone, it is located anteriorly and laterally to the posterior superior alveolar nerve and artery as they enter the posterior superior alveolar foramen. (See Figs. 65, 235, 236.) The route of the needle is from one-half to three-quarters of an inch anterior to the internal maxillary artery. As previously stated, the needle employed for this injection is 4 cm. in length, and that in the average case it will be inserted into the tissue to the extent of 3 cm., which allows one centimeter to remain exterior to the surface.

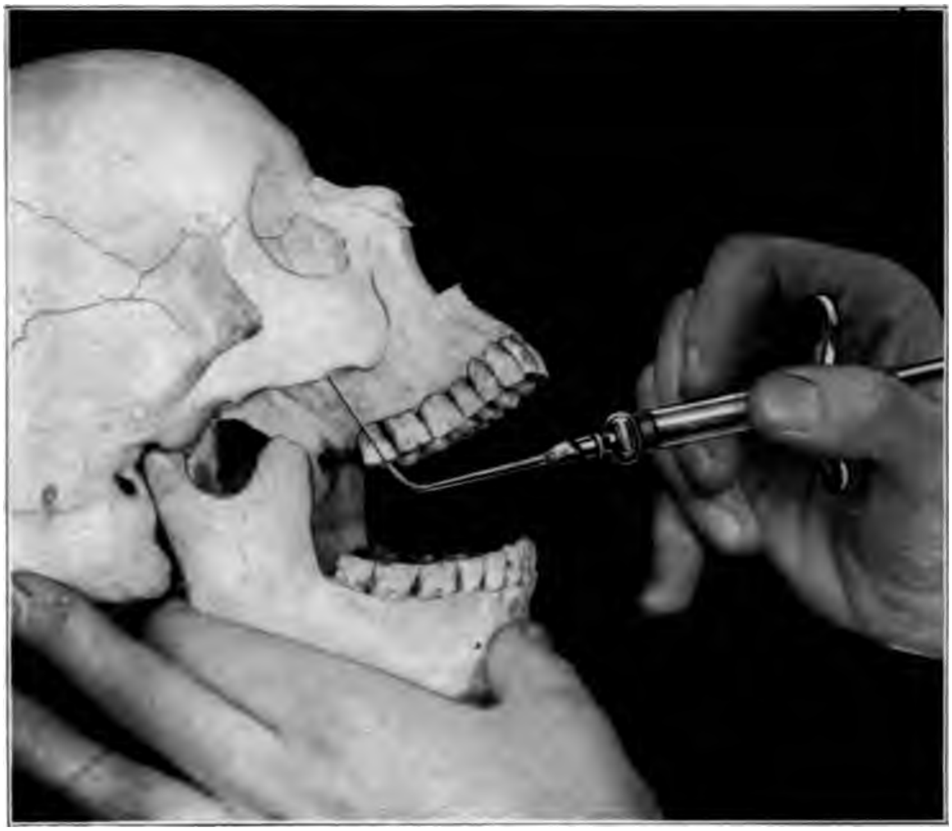


Fig. 232. Showing relationship of needle to upper third molar and lateral portion of tuberosity on skull. Note that the needle is directed upward, inward and slightly backward.

Injection of Solution.—The quantity injected is 4 mils (c.c.) of a 2 per cent procain, suprarenin Ringer solution, and if injected near the second division, the anesthetic solution will seldom infiltrate to the orbit. The anesthetic solution should be injected slowly, working the needle up and down through a distance of 3 or 4 mm.

Precautions.—This injection is made with just as much ease and accuracy as the other block injections when the operator understands the anatomy and technic. In order to obtain the best results, the following

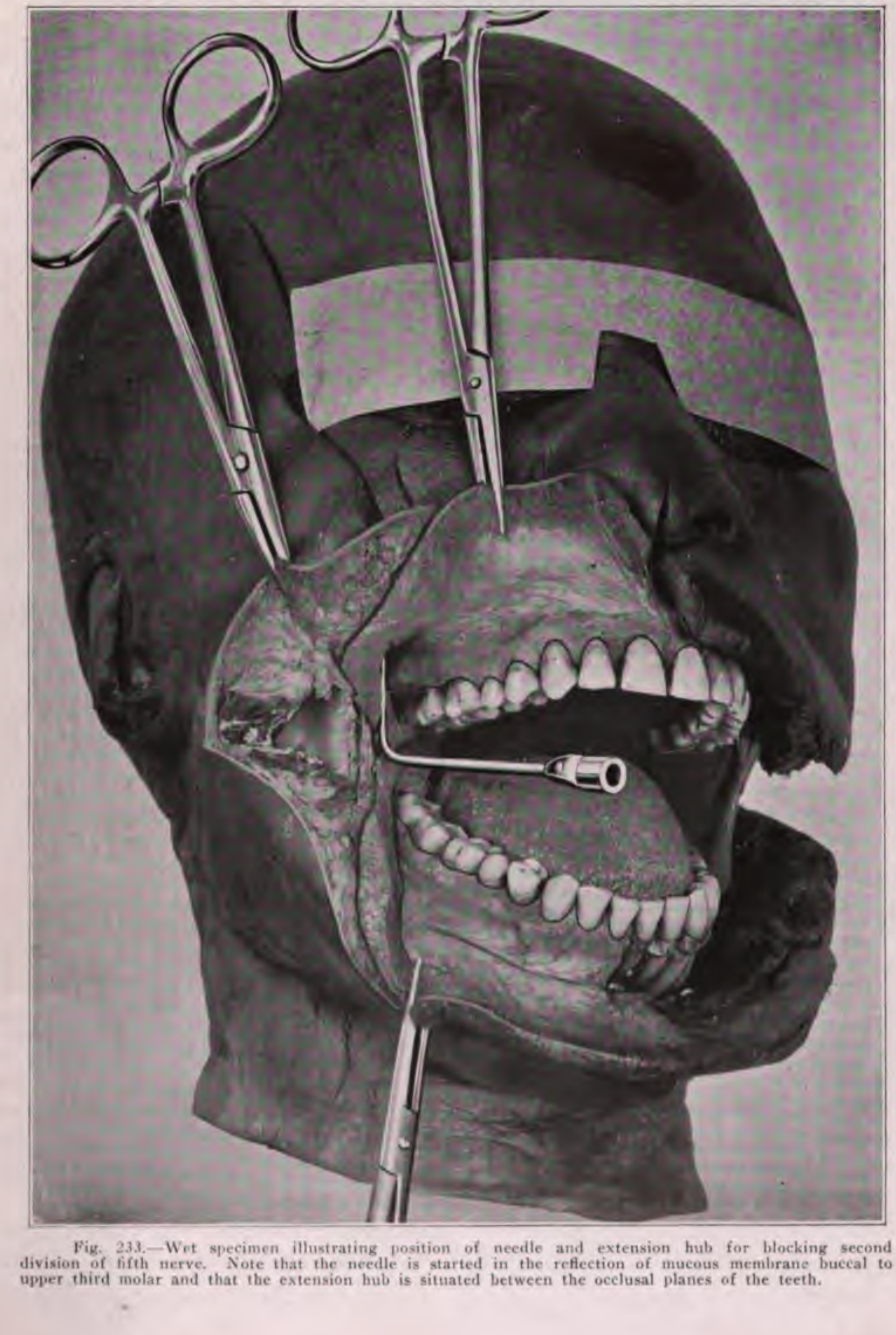


Fig. 233.—Wet specimen illustrating position of needle and extension hub for blocking second division of fifth nerve. Note that the needle is started in the reflection of mucous membrane buccal to upper third molar and that the extension hub is situated between the occlusal planes of the teeth.

points must be observed: The needle should be started in the reflection of the mucous membrane (mucous fold) located between the cheek and the gum tissue buccal to the upper third molar. (See Figs. 228, 229, 230.) This is the highest point, and the distance between this particular region and the second division is less than any other route. The needle should be directed towards the tuberosity so the bevel will come in contact with the periosteum at a depth of 1½ cm., and after this is accomplished, the needle is advanced 1½ cm. more upward, inward, and slightly backward along the periosteum covering the posterior lateral curvature of the superior maxillary bone, thus making a total depth of 30 millimeters which is the average distance to the second division. (See Figs. 235, 236, 237.)

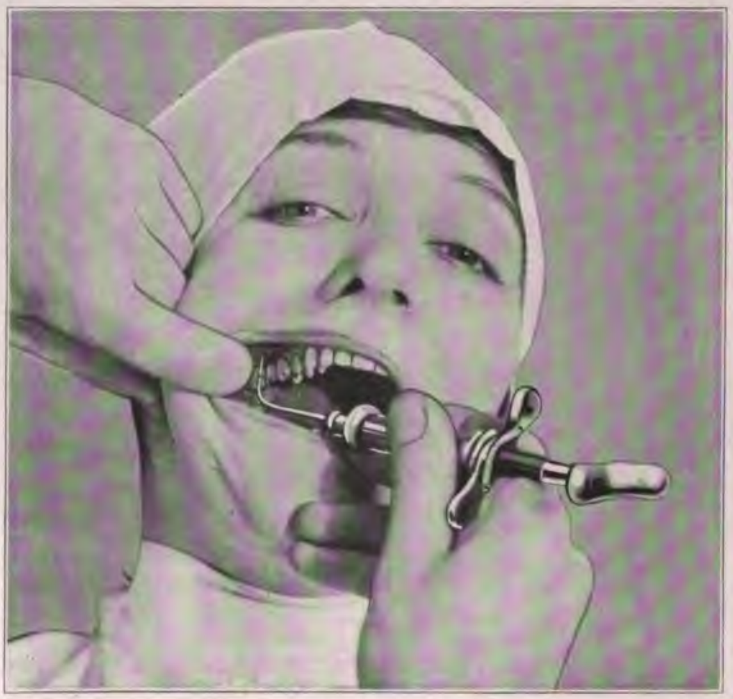


Fig. 234.—Illustrating correct position of needle and extension hub prior to injecting solution for blocking the second division. Ten millimeters of the needle are located exterior to puncture of mucous membrane. Fifteen millimeters of needle are located in mucous tissue 10 millimeters buccal to alveolar plate over third molar. Fifteen millimeters of needle are in contact with the periosteum on lateral side of tuberosity below and lateral to the second division.

Care should be exercised not to allow the needle to become engaged beneath the periosteum, for such a procedure would bind the needle to the bone and would prevent it from being inserted in the proper direction and location. After the needle has been inserted partially or entirely, no pressure should be exerted on the syringe which would act as a lever and bend the needle. It must be borne in mind that the extension hub and syringe are quite long, and when the needle is engaged in the tissue only a slight amount of leverage will cause the needle to bend, which would change its course while being advanced through the tissue, resulting in failure.

Some operators have failed to secure profound anesthesia *because they inserted the needle in a perpendicular direction and injected the solution laterally to the second division,* instead of directing the needle inward, upward, and slightly backward and depositing the solution into or near the nerve trunk. The needle should never be inserted in the tissue up to the hub; at least one centimeter should remain exterior to the starting point. Occasionally, if the

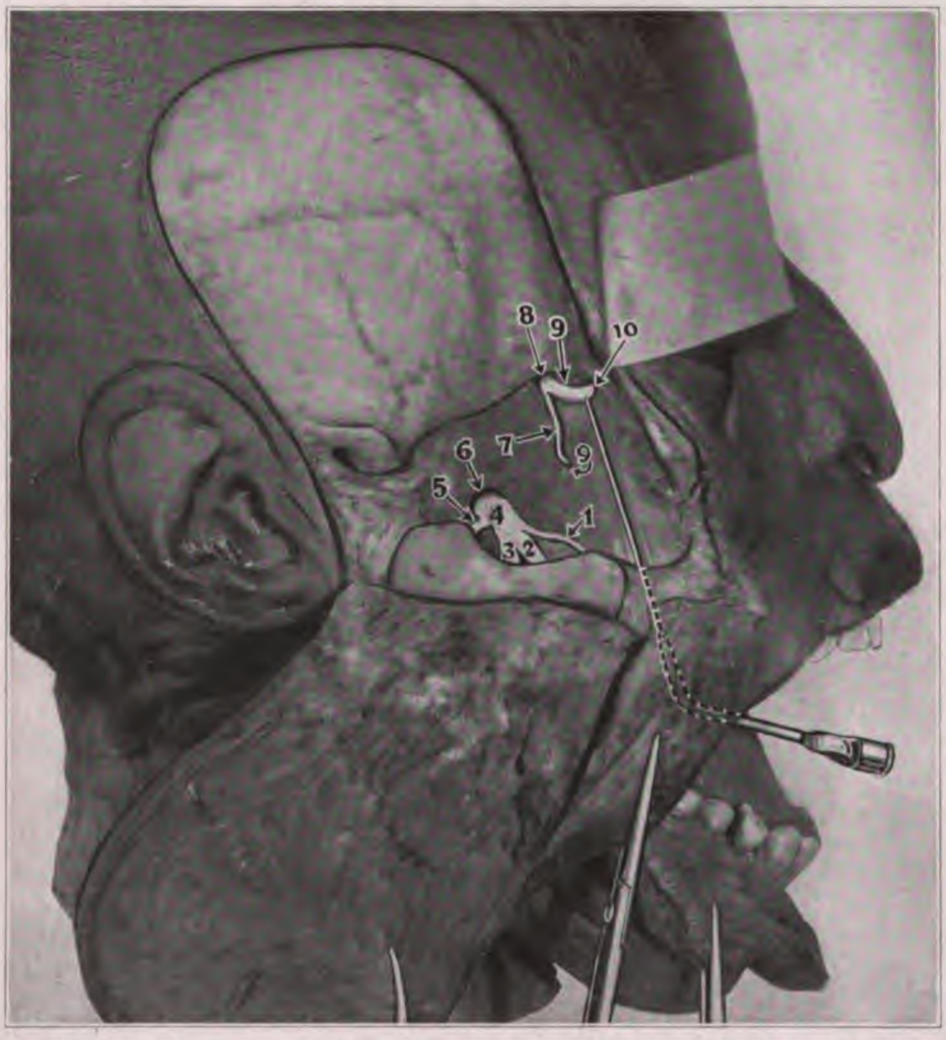


Fig. 235.—Wet specimen illustrating the needle in correct position along the lateral portion of tuberosity for blocking second division. Note point of needle in contact with the second or superior maxillary division of fifth nerve.

1, long buccal nerve; 2, lingual nerve; 3, inferior dental nerve; 4, mandibular nerve; 5, auriculotemporal nerve; 6, foramen ovale; 7, posterior superior dental nerve; 8, foramen rotundum; upper 9, second division of the fifth nerve crossing the sphenomaxillary fossa; lower 9, posterior superior dental foramen; 10, posterior part of infraorbital canal.

needle is inserted too far, or the solution infiltrates the tissues in the region of the recti muscles, it may produce a slight deviation from the normal in the movement of the eyeball, such as isophoria or exophoria. This is manifested by the patient experiencing a slight tingling or twitching sensation in the orbit, and may be followed by diplopia. If the operator should encounter a case of this character, he should not become alarmed, as the condition is only transient and will pass away along with the anesthesia, and normal function be restored.

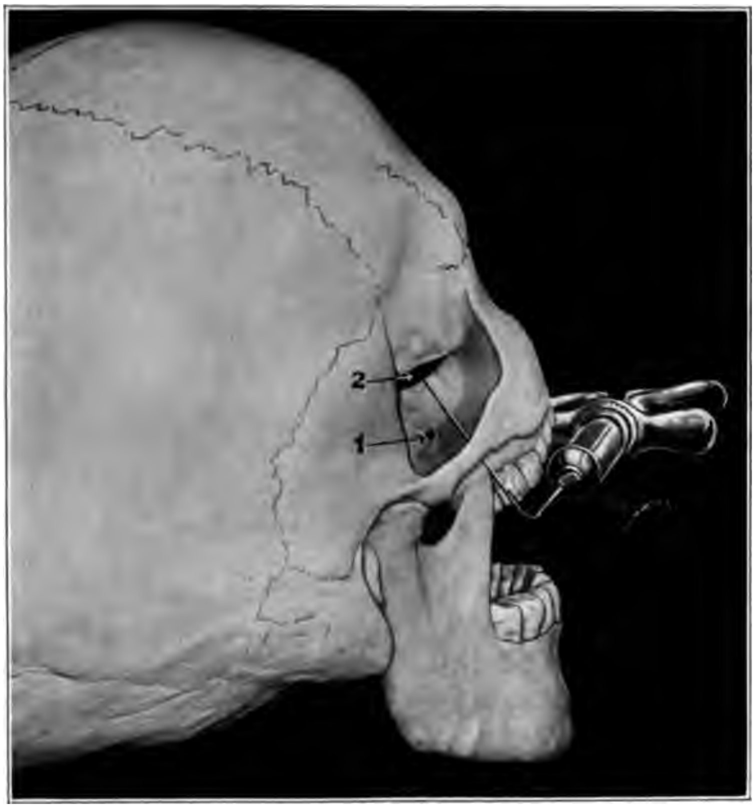


Fig. 236.—Posteriolateral view of needle for blocking second division. Note the inward inclination of the needle, which is imperative. Approximately 15 millimeters of the needle are in contact with periosteum below and lateral to second division.

1, posterior superior dental foramen; 2, second division of the fifth nerve crossing the sphenomaxillary fossa.

Time to Wait for Anesthesia.—If the solution has been injected in close contact with the second division of the fifth nerve as it crosses the sphenomaxillary fossa, the initial signs of approaching anesthesia will be experienced by the patient in most cases within three minutes. The time required for the solution to thoroughly permeate the epineurium and the second division fibers is from ten to twenty minutes. The operator should always be positive, before beginning to operate, that deep anesthesia has been secured.

Structures Anesthetized.—The injection for the second division, as it crosses the sphenomaxillary fossa, will block all nerve branches that are given off anterior to the point of injection. If the operator is familiar with the nervous anatomy, he will readily appreciate the value of this injection and the extensive area which he is enabled to block with one injection. (See Fig. 253.)

The second division of the fifth nerve and all branches which are given off this large trunk anterior to the point of injection which are completely blocked, the infraorbital nerve and its branches, i. e., lateral nasal, inferior palpebral, and superior labial; the outer nerve loop composed of the posterior, middle and anterior superior alveolar branches; the inner nerve loop which is composed of the naso- and anterior palatine branches; a portion of Meckel's ganglion and its branches, such as the posterior and middle palatine, which supply a portion of the tonsils, anterior and posterior pillars, etc. (See Fig. 237.)

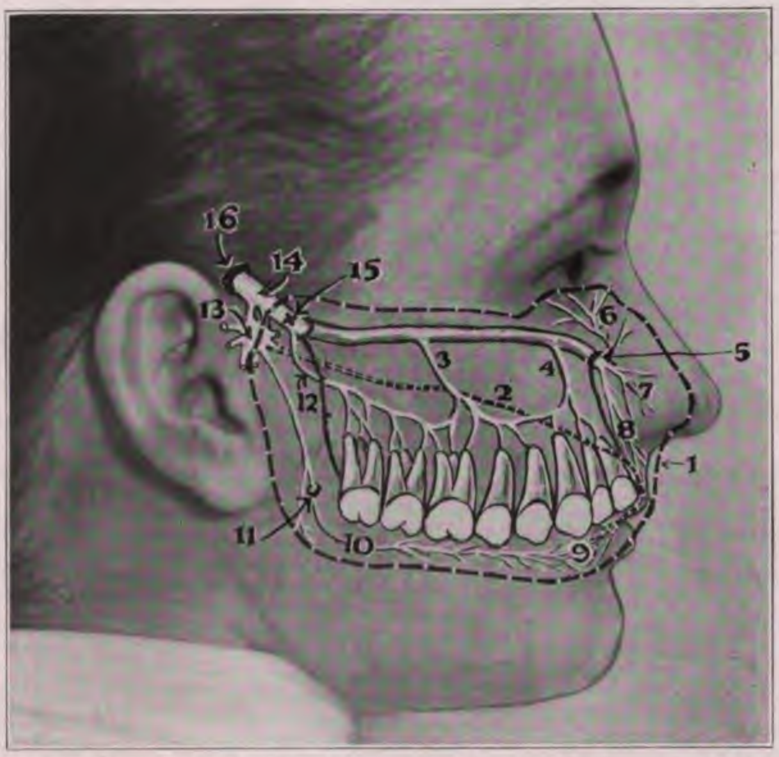


Fig. 237.—The area which is anesthetized by the second division blocking which is indicated by the outline marked 1. Solution injected at x marked 15.

2, nasopalatine nerve; 3, middle superior dental nerve; 4, anterior superior dental nerve; 5, infraorbital foramen and nerve; 6, infrapalpebral nerve; 7, lateral nasal nerve; 8, superior labial nerve; 9, overlapping of nasopalatine and anterior palatine nerves; 10, anterior palatine nerve; 11, posterior palatine foramen; 12, posterior superior dental nerve; 13, sphenopalatine ganglion; 14, second division fifth nerve; 15, location of blocking second division—indicated by x; 16, foramen rotundum.

Anesthesia following this injection enables the operator to perform extensive operations which involve the superior maxillary bone, the antrum, alveolar process, removal of teeth in corresponding half of the jaw as far anteriorly as the cuspid, plastic operations, such as harelip and skin grafting on face and nose, etc. If the operation extends near the median line, the interlacing or overlapping branches from the opposite side must be blocked.

BLOCKING THE INTERLACING OR OVERLAPPING BRANCHES

If the operation should extend near or involve the tissue, bone, or teeth, in the region of the median line, it is then necessary to make an additional injection along with the second division injection. This additional injection is not needed if the operation does not involve the tissues, teeth, or bone, etc., anterior to the cuspid. However, if the region of the lateral and central is to be operated upon, the nerve branches which pass over the median line from the opposite side must be blocked, and this is easily accomplished by making the infraorbital injection on the opposite side, from which the second division injection has been made. (See page 459 for infraorbital injection.)

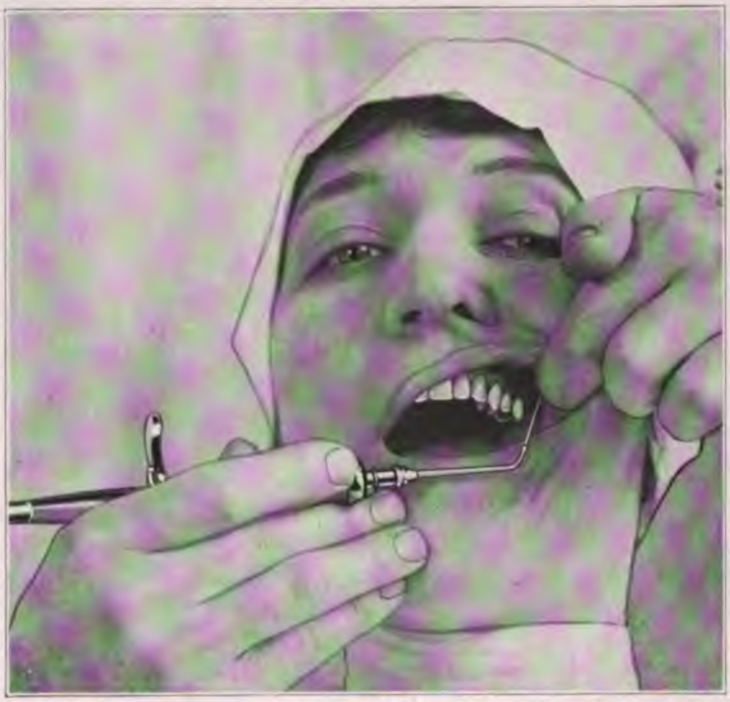


Fig. 238.—Advancing the needle in the mucous tissue at reflection buccal to the upper third molar for blocking the second or superior maxillary division of fifth nerve on left side. Similar technic is employed as for blocking the second division on the right side.

If a plastic operation is to be performed, one should employ the infraorbital injection. If the teeth and alveolar process are to be operated upon, the intraosseous method may be used by making the injection above and between the apices of the roots of the lateral and central incisors on the same side of the second division injection. (See page 489 for intraosseous technic.) The infiltration or terminal method may also be used. (See technic on page 479.)

ADVANTAGES OF BLOCKING THE SECOND DIVISION OF THE FIFTH NERVE BY THE INTRAORAL ROUTE OVER THE EXTRAORAL ROUTE

1. The distance between the puncture point, which is in the mucous fold, and the second division is in the average case 3 cm., whereas by the extraoral method the distance from the puncture point in the skin to the second division is usually 5 cm.
2. The route of the needle is anterior and lateral to the internal maxillary artery. Therefore, the possibility of inserting the needle into the internal maxillary artery is eliminated.
3. This route which has been selected for the needle is by far the shortest distance of any method which has been presented by the extraoral or orbital routes.
4. Little or no pain is inflicted upon the patient while inserting the needle and making the injection. No preliminary injection is required, as is the case when the needle is inserted through the skin from the exterior.
5. The technic is more readily executed, and the results are more certain than by the extraoral or orbital routes.
6. The needle is not inserted through muscle tissue, which is the case by the extraoral route.
7. When the second division is blocked on both sides, only two needle punctures are necessary, and a smaller quantity of solution is required to block the entire upper jaw than when several other intraoral injections are made.
8. No postoperative pain or complications will follow if the injection has been properly made.

EXTENT OF OPERATIONS WHICH CAN BE PERFORMED FOLLOWING THE BLOCKING OF THE SECOND DIVISION OF THE FIFTH CRANIAL NERVE

Only two injections are necessary to block the entire upper jaw by this route. Otherwise several other injections would be necessary to block the same area. A larger quantity of solution would be necessary to accomplish the same purpose by the several injections than that which is employed with the two intraoral second division injections.

The following operations can be performed:

1. Aveolectomy.
2. Extirpation of pulps.
3. Extraction of the first and second bicuspids; first, second and third molars, and including the cuspid in 75 per cent of cases following the blocking

of either the right or left second divisions. In case all the upper teeth are to be extracted, both the right and left second divisions are blocked. In case the teeth are to be extracted up to the median line, then an additional injection is made to block the interlacing branches, in addition to the right or left second division injection. (See page 392 for "Blocking the Interlacing or Overlapping Branches.")

4. Resection of the superior maxillary bone.
5. Reduction and splinting in the treatment of superior maxillary fracture.
6. Antrum operations (plus interlacing injection).
7. Nasal operations (plus interlacing injection).
8. Plastic operations, such as harelip, skin grafting, etc., (plus interlacing injection).
9. Curettement of pus pockets in the treatment of pyorrhea alveolaris.
10. Extensive cavity preparation.

INDICATIONS FOR BLOCKING THE SECOND DIVISION OF THE FIFTH NERVE BY THE INTRAORAL ROUTE

This injection is of inestimable value in oral surgery as it produces the same results as are accomplished by several injections which are necessary to block the same area. This injection should be used only when indicated, for the reason that anesthesia should not be produced over any larger area than is absolutely necessary to perform the operation in question.

This injection is likewise of great value in the treatment of pyorrhea alveolaris, in curetting pus pockets, for the extraction of several teeth on one side of the arch, or, in case it is necessary, to remove all the teeth in the upper arch.

The writer quotes from a letter received from Dr. Jules J. Sarrazin, of New Orleans, with reference to the blocking of the second division by the intraoral method. He says: "Every now and then, sometimes after patients have suffered for a couple of weeks as the result of ruthless extraction of teeth, I find it necessary both to give relief from pain and to guard against immediate tissue destruction and remote infection, in the course of my stomatological work to trim the septa and to curette the sockets, and occasionally bur the bone, also suture flaps over fresh healthy clots so that healing can take place without danger to health. All this is satisfactorily accomplished under nerve blocking anesthesia, and incidentally the more experience I have, the more I care only for the intraoral second division injection, and the inferior dental lingual injection, and blocking the interlacing branches from the opposite side. This is due largely to the fact that I need a larger field than the operative dentist or the exodontist."

Dr. E. A. Litchfield reports that up to date he has made 97 deep block injections for the second division by the intraoral method, and of this number 89 were perfect results, six with partial anesthesia, and two failures. Dr. F. F. Molt, Chicago, states that he has experienced very few failures following a large number of second division injections. Dr. John W. Seybold, Denver; Dr. C. R. Lawrence, Enid, Oklahoma; Lieutenant H. C. Miller, Great Lakes Naval Training Station; Dr. J. P. Henahan, Cleveland, Ohio; Dr. Emmet Craig, Kansas City; Dr. R. F. Lucas, South Bend, Indiana; Dr. John J. Ogden, Memphis, Tennessee; Dr. J. A. Blue, Birmingham, Alabama; Dr. Albert Hallenberg, Fargo, North Dakota; Dr. Roy S. Hopkinson, Milwaukee, Wisconsin, and numerous other operators, who have made a large number of these injections, have sent gratifying reports.

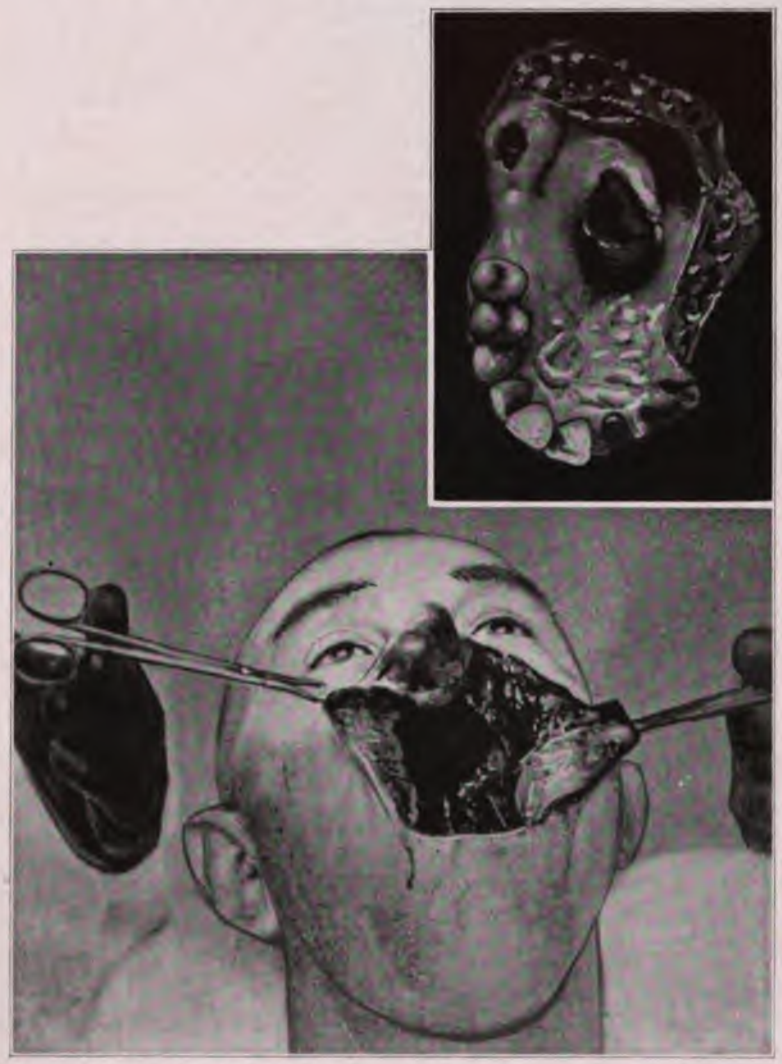


Fig. 239.—Removal of greater part of hard palate and superior maxillary bone for carcinoma—operation performed under nerve blocking. (After Braun.)

CONTRAINDICATIONS FOR BLOCKING THE SECOND DIVISION OF THE FIFTH NERVE BY THE INTRAORAL ROUTE

It should be the aim of the operator to inject as little solution as possible, and to produce as small an area as possible to suffice for the operation to be performed. Therefore, this injection should never be employed if only one or two teeth are to be extracted, or a similar operation which only involves a small area. It must always be remembered that the blocking of the second division anesthetizes an extensive area, and should not be employed when one of the other intraoral injections, which produces a smaller area of anesthesia, will suffice, unless such an injection is contraindicated, by infection or other causes. This injection is also contraindicated in case extensive inflammation or infection is present within the oral cavity, but instead the second division is blocked by the extraoral route.

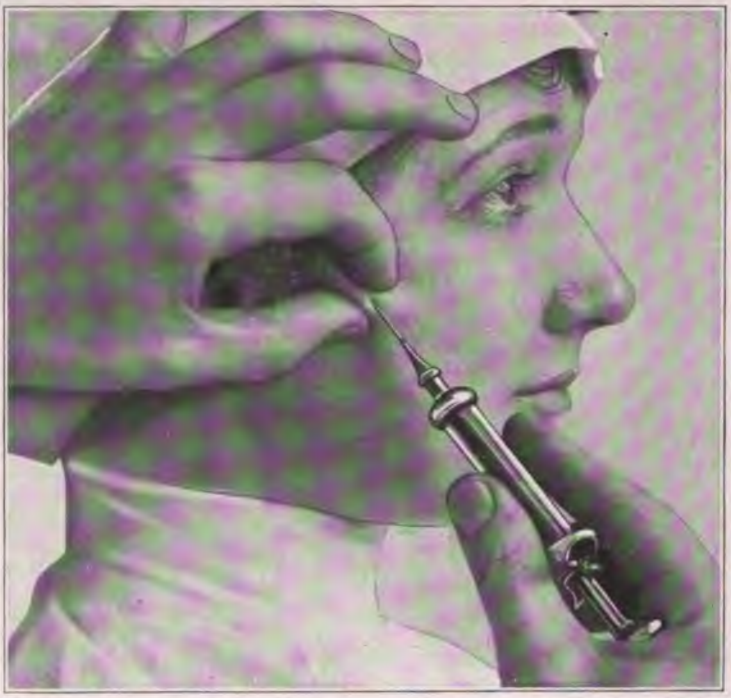


Fig. 240.—Making a preliminary injection into and beneath the skin with a very fine sharp needle such as needle No. 7. This injection is made prior to using the regular nerve blocking needle for blocking the second division of the fifth nerve by the extraoral method.

BLOCKING THE SECOND OR SUPERIOR MAXILLARY DIVISION OF THE FIFTH CRANIAL NERVE BY THE EXTRAORAL METHOD

The blocking of this large nerve trunk by the extraoral route is accomplished by injecting the solution near the second division as it crosses the

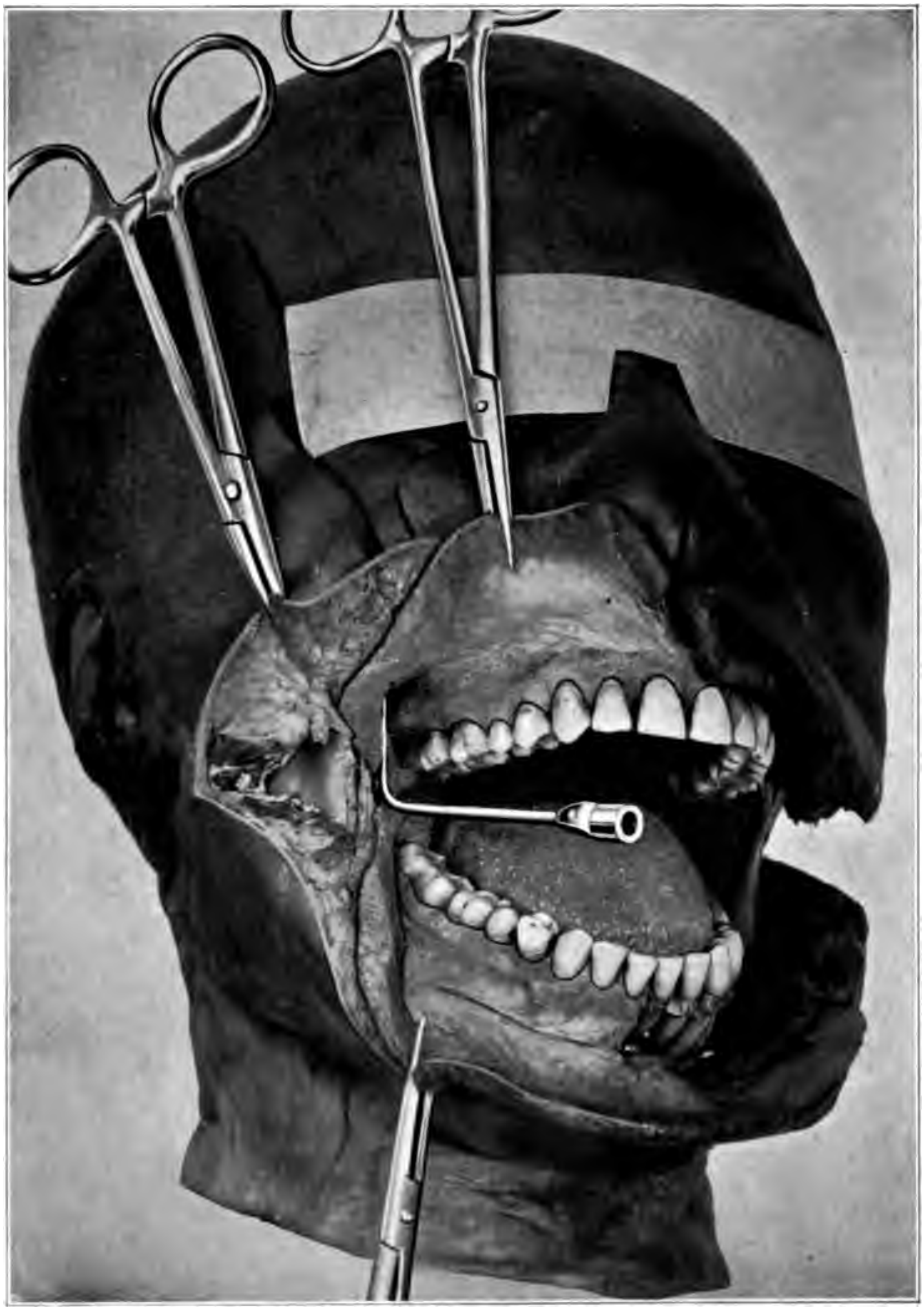


Fig. 233.—Wet specimen illustrating position of needle and extension hub for blocking second division of fifth nerve. Note that the needle is started in the reflection of mucous membrane buccal to upper third molar and that the extension hub is situated between the occlusal planes of the teeth.

points must be observed: The needle should be started in the reflection of the mucous membrane (mucous fold) located between the cheek and the gum tissue buccal to the upper third molar. (See Figs. 228, 229, 230.) This is the highest point, and the distance between this particular region and the second division is less than any other route. The needle should be directed towards the tuberosity so the bevel will come in contact with the periosteum at a depth of $1\frac{1}{2}$ cm., and after this is accomplished, the needle is advanced $1\frac{1}{2}$ cm. more upward, inward, and slightly backward along the periosteum covering the posterior lateral curvature of the superior maxillary bone, thus making a total depth of 30 millimeters which is the average distance to the second division. (See Figs. 235, 236, 237.)

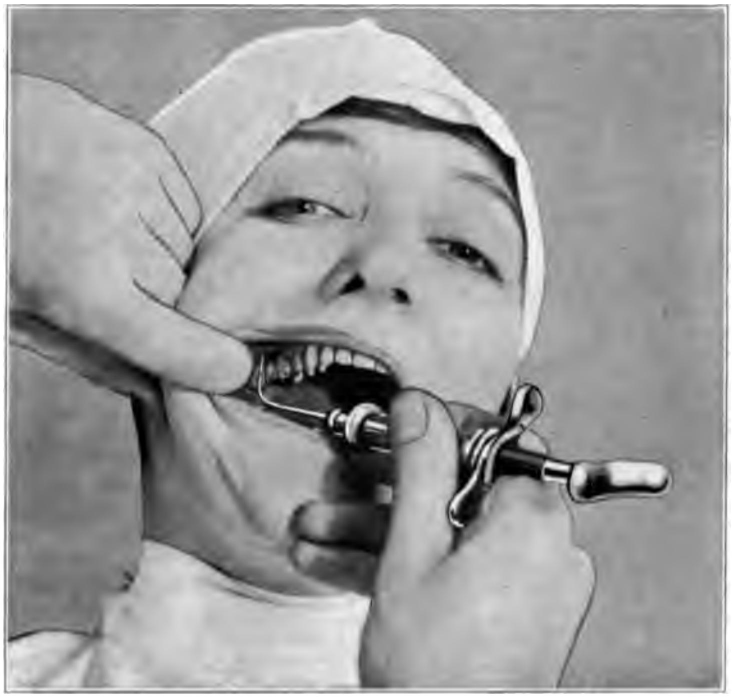


Fig. 234.—Illustrating correct position of needle and extension hub prior to injecting solution for blocking the second division. Ten millimeters of the needle are located exterior to puncture of mucous membrane. Fifteen millimeters of needle are located in mucous tissue 10 millimeters buccal to alveolar plate over third molar. Fifteen millimeters of needle are in contact with the periosteum on lateral side of tuberosity below and lateral to the second division.

Care should be exercised not to allow the needle to become engaged beneath the periosteum, for such a procedure would bind the needle to the bone and would prevent it from being inserted in the proper direction and location. After the needle has been inserted partially or entirely, no pressure should be exerted on the syringe which would act as a lever and bend the needle. It must be borne in mind that the extension hub and syringe are quite long, and when the needle is engaged in the tissue only a slight amount of leverage will cause the needle to bend, which would change its course while being advanced through the tissue, resulting in failure.

Some operators have failed to secure profound anesthesia *because they inserted the needle in a perpendicular direction and injected the solution laterally to the second division,* instead of directing the needle inward, upward, and slightly backward and depositing the solution into or near the nerve trunk. The needle should never be inserted in the tissue up to the hub; at least one centimeter should remain exterior to the starting point. Occasionally, if the

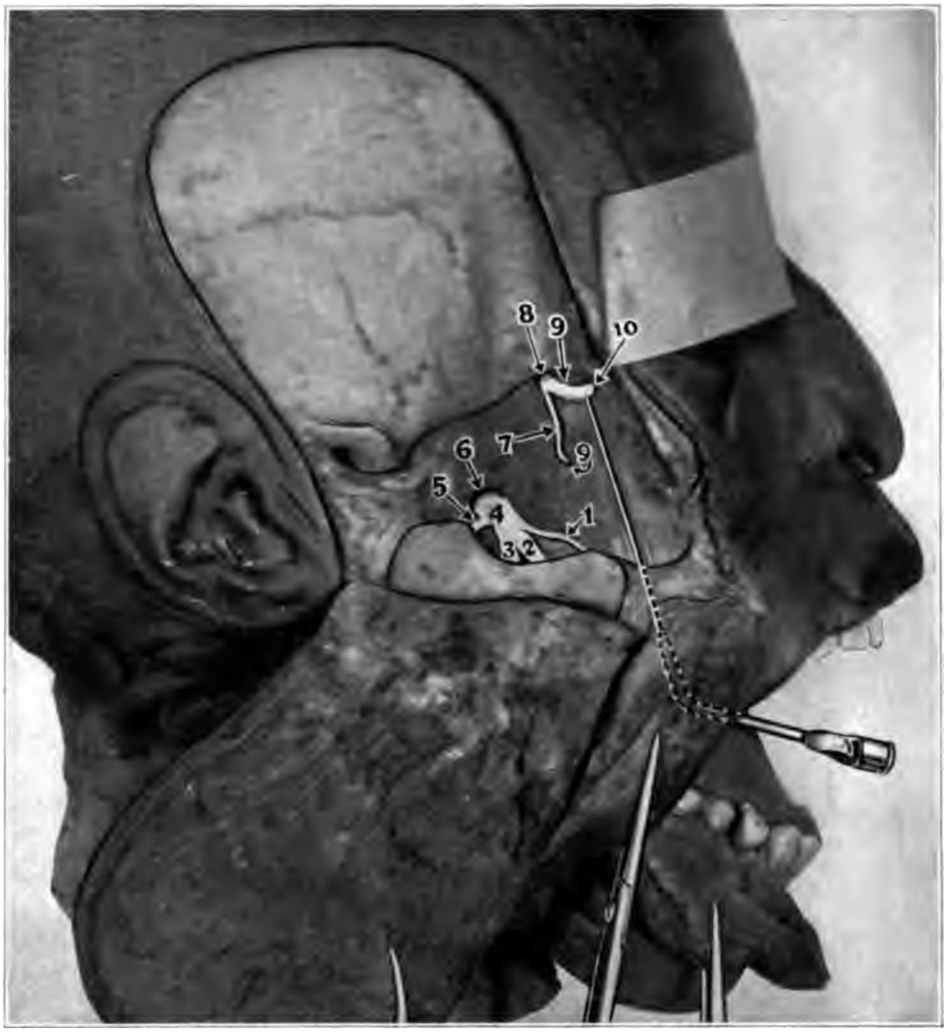


Fig. 235.—Wet specimen illustrating the needle in correct position along the lateral portion of tuberosity for blocking second division. Note point of needle in contact with the second or superior maxillary division of fifth nerve.

1, long buccal nerve; 2, lingual nerve; 3, inferior dental nerve; 4, mandibular nerve; 5, auriculotemporal nerve; 6, foramen ovale; 7, posterior superior dental nerve; 8, foramen rotundum; upper 9, second division of the fifth nerve crossing the sphenomaxillary fossa; lower 9, posterior superior dental foramen; 10, posterior part of infraorbital canal.

needle is inserted too far, or the solution infiltrates the tissues in the region of the recti muscles, it may produce a slight deviation from the normal in the movement of the eyeball, such as isophoria or exophoria. This is manifested by the patient experiencing a slight tingling or twitching sensation in the orbit, and may be followed by diplopia. If the operator should encounter a case of this character, he should not become alarmed, as the condition is only transient and will pass away along with the anesthesia, and normal function be restored.

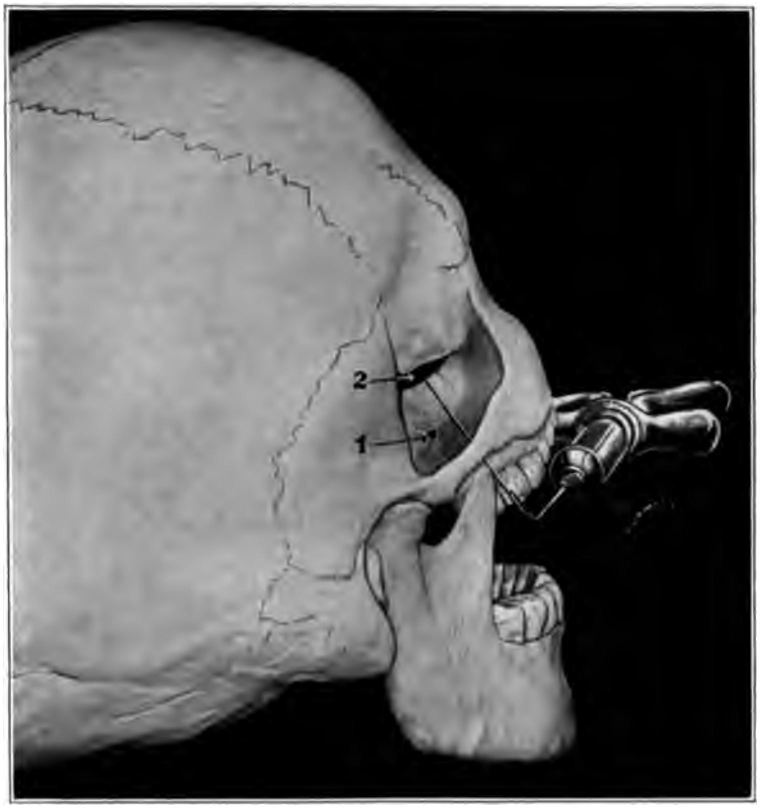


Fig. 236.—Posteriolateral view of needle for blocking second division. Note the inward inclination of the needle, which is imperative. Approximately 15 millimeters of the needle are in contact with periosteum below and lateral to second division.

1, posterior superior dental foramen; 2, second division of the fifth nerve crossing the sphenomaxillary fossa.

Time to Wait for Anesthesia.—If the solution has been injected in close contact with the second division of the fifth nerve as it crosses the sphenomaxillary fossa, the initial signs of approaching anesthesia will be experienced by the patient in most cases within three minutes. The time required for the solution to thoroughly permeate the epineurium and the second division fibers is from ten to twenty minutes. The operator should always be positive, before beginning to operate, that deep anesthesia has been secured.

Structures Anesthetized.—The injection for the second division, as it crosses the sphenomaxillary fossa, will block all nerve branches that are given off anterior to the point of injection. If the operator is familiar with the nervous anatomy, he will readily appreciate the value of this injection and the extensive area which he is enabled to block with one injection. (See Fig. 253.)

The second division of the fifth nerve and all branches which are given off this large trunk anterior to the point of injection which are completely blocked, the infraorbital nerve and its branches, i. e., lateral nasal, inferior palpebral, and superior labial; the outer nerve loop composed of the posterior, middle and anterior superior alveolar branches; the inner nerve loop which is composed of the naso- and anterior palatine branches; a portion of Meckel's ganglion and its branches, such as the posterior and middle palatine, which supply a portion of the tonsils, anterior and posterior pillars, etc. (See Fig. 237.)

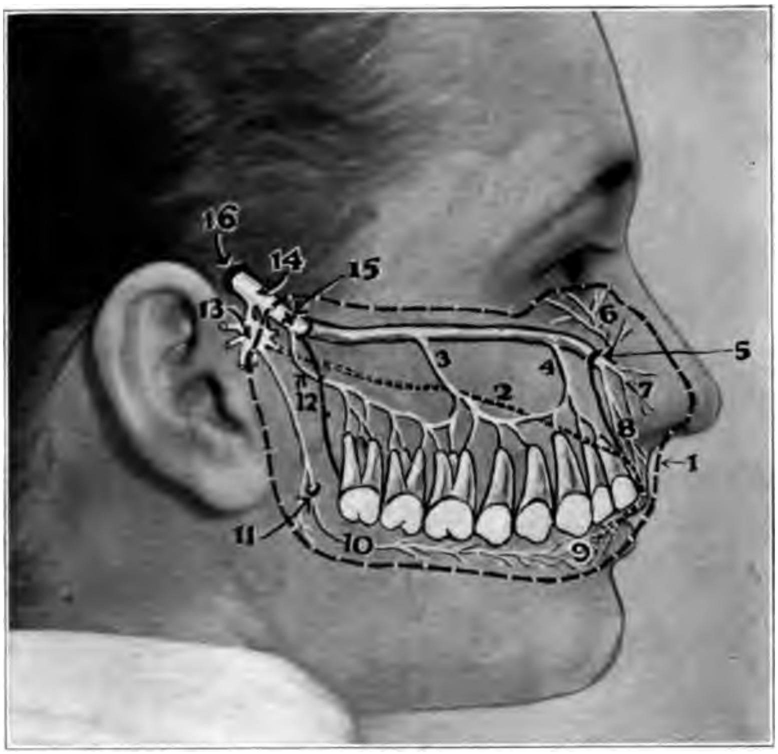


Fig. 237.—The area which is anesthetized by the second division blocking which is indicated by the outline marked 1. Solution injected at x marked 15.

2, nasopalatine nerve; 3, middle superior dental nerve; 4, anterior superior dental nerve; 5, infraorbital foramen and nerve; 6, infrapalpebral nerve; 7, lateral nasal nerve; 8, superior labial nerve; 9, overlapping of nasopalatine and anterior palatine nerves; 10, anterior palatine nerve; 11, posterior palatine foramen; 12, posterior superior dental nerve; 13, sphenopalatine ganglion; 14, second division fifth nerve; 15, location of blocking second division—indicated by x; 16, foramen rotundum.

Anesthesia following this injection enables the operator to perform extensive operations which involve the superior maxillary bone, the antrum, alveolar process, removal of teeth in corresponding half of the jaw as far anteriorly as the cuspid, plastic operations, such as harelip and skin grafting on face and nose, etc. If the operation extends near the median line, the interlacing or overlapping branches from the opposite side must be blocked.

BLOCKING THE INTERLACING OR OVERLAPPING BRANCHES

If the operation should extend near or involve the tissue, bone, or teeth, in the region of the median line, it is then necessary to make an additional injection along with the second division injection. This additional injection is not needed if the operation does not involve the tissues, teeth, or bone, etc., anterior to the cuspid. However, if the region of the lateral and central is to be operated upon, the nerve branches which pass over the median line from the opposite side must be blocked, and this is easily accomplished by making the infraorbital injection on the opposite side, from which the second division injection has been made. (See page 459 for infraorbital injection.)

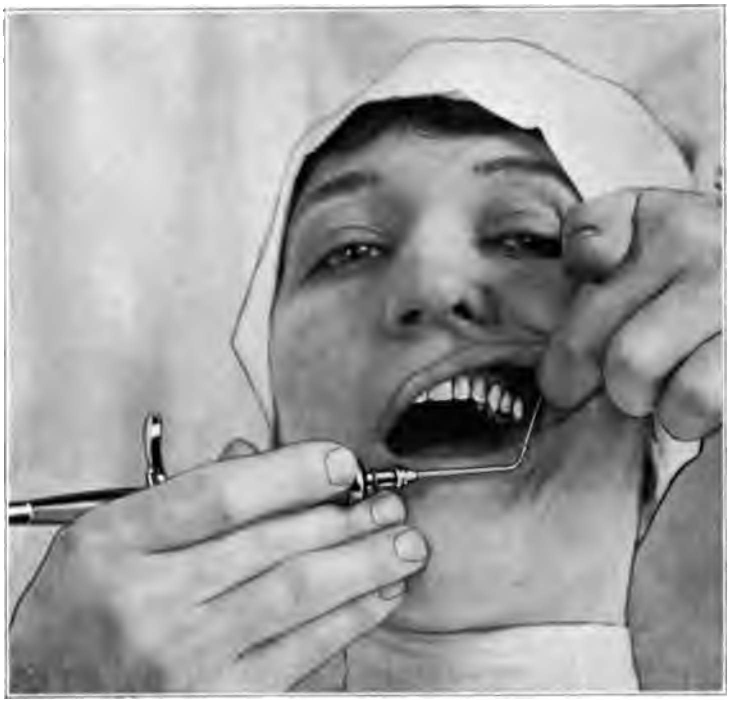


Fig. 238.—Advancing the needle in the mucous tissue at reflection buccal to the upper third molar for blocking the second or superior maxillary division of fifth nerve on left side. Similar technic is employed as for blocking the second division on the right side.

If a plastic operation is to be performed, one should employ the infraorbital injection. If the teeth and alveolar process are to be operated upon, the intraosseous method may be used by making the injection above and between the apices of the roots of the lateral and central incisors on the same side of the second division injection. (See page 489 for intraosseous technic.) The infiltration or terminal method may also be used. (See technic on page 479.)

ADVANTAGES OF BLOCKING THE SECOND DIVISION OF THE FIFTH NERVE BY THE INTRAORAL ROUTE OVER THE EXTRAORAL ROUTE

1. The distance between the puncture point, which is in the mucous fold, and the second division is in the average case 3 cm., whereas by the extraoral method the distance from the puncture point in the skin to the second division is usually 5 cm.
2. The route of the needle is anterior and lateral to the internal maxillary artery. Therefore, the possibility of inserting the needle into the internal maxillary artery is eliminated.
3. This route which has been selected for the needle is by far the shortest distance of any method which has been presented by the extraoral or orbital routes.
4. Little or no pain is inflicted upon the patient while inserting the needle and making the injection. No preliminary injection is required, as is the case when the needle is inserted through the skin from the exterior.
5. The technic is more readily executed, and the results are more certain than by the extraoral or orbital routes.
6. The needle is not inserted through muscle tissue, which is the case by the extraoral route.
7. When the second division is blocked on both sides, only two needle punctures are necessary, and a smaller quantity of solution is required to block the entire upper jaw than when several other intraoral injections are made.
8. No postoperative pain or complications will follow if the injection has been properly made.

EXTENT OF OPERATIONS WHICH CAN BE PERFORMED FOLLOWING THE BLOCKING OF THE SECOND DIVISION OF THE FIFTH CRANIAL NERVE

Only two injections are necessary to block the entire upper jaw by this route. Otherwise several other injections would be necessary to block the same area. A larger quantity of solution would be necessary to accomplish the same purpose by the several injections than that which is employed with the two intraoral second division injections.

The following operations can be performed:

1. Aveolectomy.
2. Extirpation of pulps.
3. Extraction of the first and second bicuspids; first, second and third molars, and including the cuspid in 75 per cent of cases following the blocking

of either the right or left second divisions. In case all the upper teeth are to be extracted, both the right and left second divisions are blocked. In case the teeth are to be extracted up to the median line, then an additional injection is made to block the interlacing branches, in addition to the right or left second division injection. (See page 392 for "Blocking the Interlacing or Overlapping Branches.")

4. Resection of the superior maxillary bone.
5. Reduction and splinting in the treatment of superior maxillary fracture.
6. Antrum operations (plus interlacing injection).
7. Nasal operations (plus interlacing injection).
8. Plastic operations, such as harelip, skin grafting, etc., (plus interlacing injection).
9. Curettement of pus pockets in the treatment of pyorrhea alveolaris.
10. Extensive cavity preparation.

INDICATIONS FOR BLOCKING THE SECOND DIVISION OF THE FIFTH NERVE BY THE INTRAORAL ROUTE

This injection is of inestimable value in oral surgery as it produces the same results as are accomplished by several injections which are necessary to block the same area. This injection should be used only when indicated, for the reason that anesthesia should not be produced over any larger area than is absolutely necessary to perform the operation in question.

This injection is likewise of great value in the treatment of pyorrhea alveolaris, in curetting pus pockets, for the extraction of several teeth on one side of the arch, or, in case it is necessary, to remove all the teeth in the upper arch.

The writer quotes from a letter received from Dr. Jules J. Sarrazin, of New Orleans, with reference to the blocking of the second division by the intraoral method. He says: "Every now and then, sometimes after patients have suffered for a couple of weeks as the result of ruthless extraction of teeth, I find it necessary both to give relief from pain and to guard against immediate tissue destruction and remote infection, in the course of my stomatological work to trim the septa and to curette the sockets, and occasionally bur the bone, also suture flaps over fresh healthy clots so that healing can take place without danger to health. All this is satisfactorily accomplished under nerve blocking anesthesia, and incidentally the more experience I have, the more I care only for the intraoral second division injection, and the inferior dental lingual injection, and blocking the interlacing branches from the opposite side. This is due largely to the fact that I need a larger field than the operative dentist or the exodontist."

Dr. E. A. Litchfield reports that up to date he has made 97 deep block injections for the second division by the intraoral method, and of this number 89 were perfect results, six with partial anesthesia, and two failures. Dr. F. F. Molt, Chicago, states that he has experienced very few failures following a large number of second division injections. Dr. John W. Seybold, Denver; Dr. C. R. Lawrence, Enid, Oklahoma; Lieutenant H. C. Miller, Great Lakes Naval Training Station; Dr. J. P. Henahan, Cleveland, Ohio; Dr. Emmet Craig, Kansas City; Dr. R. F. Lucas, South Bend, Indiana; Dr. John J. Ogden, Memphis, Tennessee; Dr. J. A. Blue, Birmingham, Alabama; Dr. Albert Hallenberg, Fargo, North Dakota; Dr. Roy S. Hopkinson, Milwaukee, Wisconsin, and numerous other operators, who have made a large number of these injections, have sent gratifying reports.

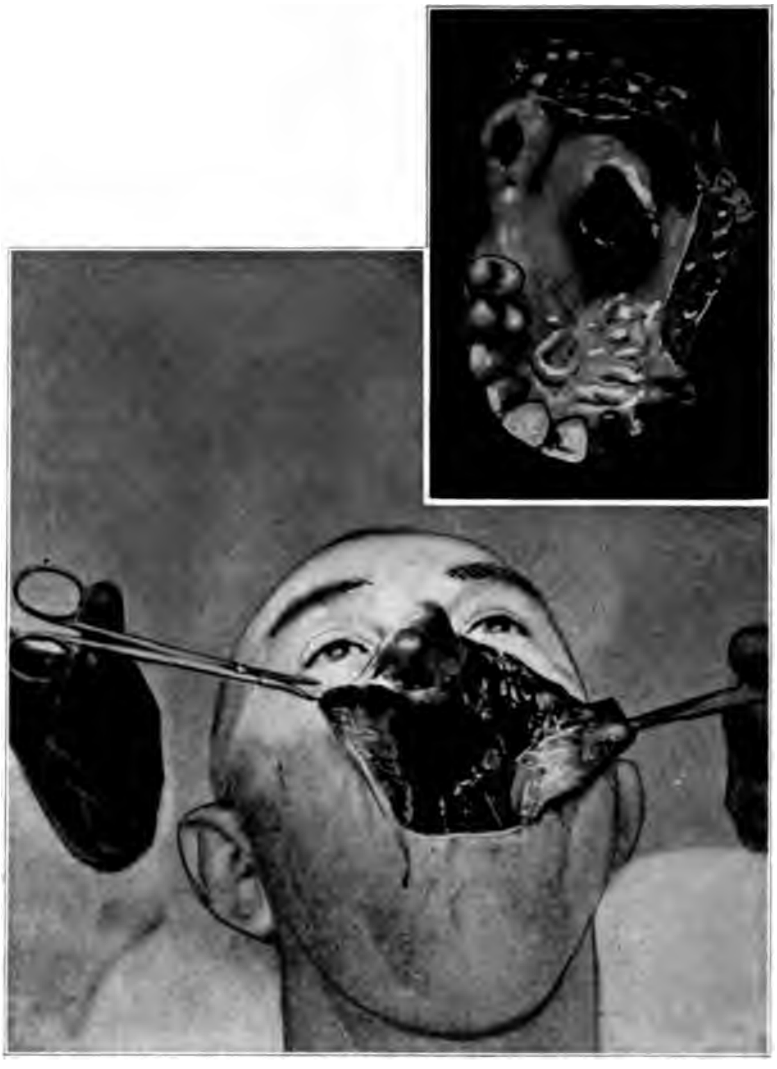


Fig. 239.—Removal of greater part of hard palate and superior maxillary bone for carcinoma—operation performed under nerve blocking. (After Braun.)

sphenomaxillary fossa, located between the foramen rotundum of the sphenoid bone and the posterior inferior portion of the floor of the orbit. (See Figs. 40, 42, 51, 53, and 60.) The sphenomaxillary fossa differs in width with different individuals; the approximate width in the average adult is 1½ cm. (See Figs. 54-*A*, 64, and 65.) The injection of the solution at this point will produce anesthesia of all of those branches that are given off the second division of the fifth nerve anterior to the point of injection, and in most cases the sphenopalatine (Meckel's) ganglion and its branches.

Needles Employed.—Two needles are used for this injection. Needle No. 7 (see Fig. 177) is called the preliminary needle and is used for making the

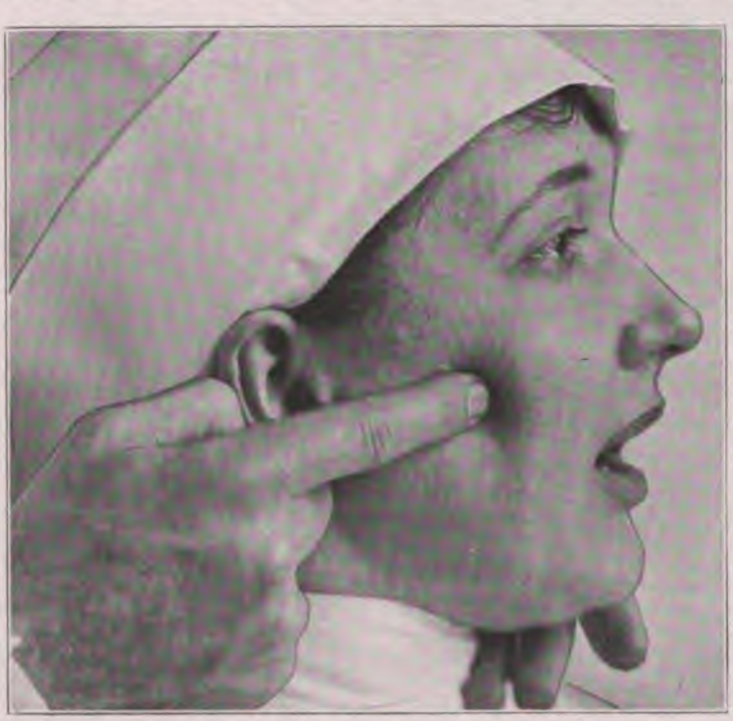


Fig. 241.—Locating the anterior border of the coronoid process of mandible and the lower border of the zygoma and zygomatic bone with the tip of the index finger. The patient is requested to open and close his mouth. This aids the operator to quickly locate the bony landmarks.

initial injection into the skin, prior to inserting the longer needle, to deposit the solution in the region of the nerve trunk. This needle is made of iridio-platinum, is very fine and sharp, it being only 27 gauge and 1 cm. in length. Needle No. 8 (See Fig. 177) is 60 mm. long, 20 gauge, iridio-platinum, and is used following the preliminary needle.

Technic of Injection.—The technic employed for blocking the second division by the extraoral route is as follows: Prepare the skin to receive the needle by washing with soap and water, followed by benzin or iodin, or with a solution of 1/1000 bichlorid of mercury. Following this procedure a preliminary or initial injection is made into and beneath the skin with a very fine hypodermic needle, which has previously been described. At least one and a half mils of the solution should be injected at this point, which will eliminate the pain following the insertion of the regular needle through the skin and other tissues. The skin is grasped between the index finger and thumb, and pressure is brought upon it for several minutes, gradually increasing the pressure, which will eliminate the pain from the insertion of the fine sharp preliminary needle. When the point of the needle has entered the skin several minims of solution are slowly injected. A wheal, at least 2 cm. in diameter, should be produced by the preliminary injection. (See Fig. 240.) Following this the regular needle, used for the blocking of the second division by the extraoral method, which is 60 millimeters long and 20 gauge, is employed.

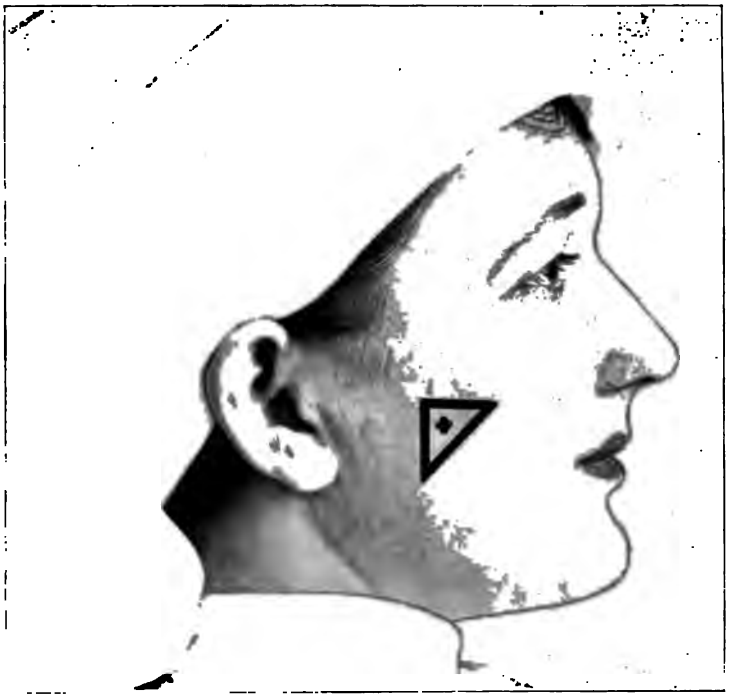


Fig. 242. The horizontal line indicates the lower border of the zygoma and zygomatic bone. The perpendicular line indicates the anterior border of the coronoid process. The line connecting the horizontal with the perpendicular is to form a triangle. The horizontal and perpendicular lines should be at least 2 centimeters each in length. The X situated within the triangle indicates the location of puncture of the skin by needle.

The next procedure in the technic is to locate the various bony landmarks. With the tip of the index finger locate the anterior margin of the coronoid process of the mandible and the lower border of the malar bone. This is best accomplished by having the patient open and close his mouth slightly, if possible, at the same time exerting pressure over this area with the tip of the index finger. (See Fig. 241.) If it is possible for the patient to open his mouth slightly, pressure at this point readily locates this particular region. However, if the patient is suffering from a fracture or from some pathological condition of the superior or inferior maxillary bone, which would cause a great deal of pain due to the palpation, the operator should rely on pressure in locating the desired area without requesting the patient to manipulate the lower jaw. After locating the lower margin of the malar bone, a line is drawn upon the skin with a dermographic pencil, or with tincture of iodin, parallel to the lower surface of this bone. Another line is drawn which is a perpendicular one and parallel to the anterior surface of the coronoid process of the mandible. The horizontal line which represents the lower border of the malar bone, and the perpendicular line which represents the anterior surface of the coronoid process of the mandible should each be at least 2 cm. in length. The two lines form a right angle. Next, draw a line connecting the

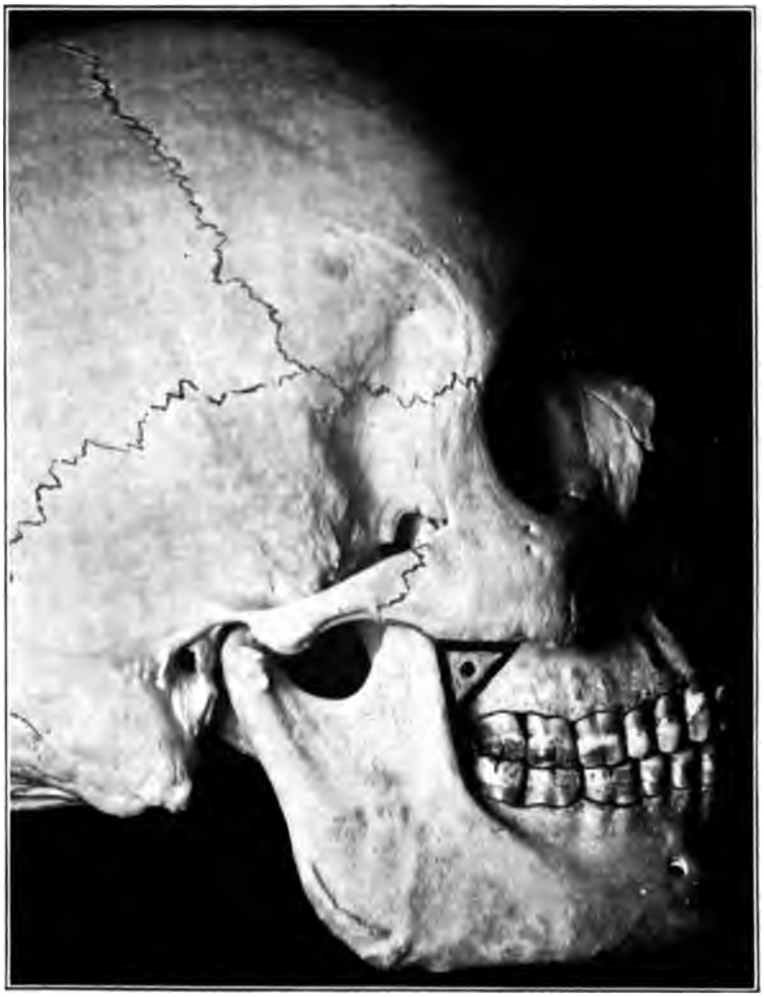


Fig. 243.--Illustrating the outline of the bony landmarks indicated by the triangle. The dot situated within the triangle represents the position of puncture point. (See Fig. 244.)

two right angle lines which will form a triangle. (See Figs. 242 and 243.) After a sufficient length of time has elapsed for the preliminary injection to produce deep anesthesia of the skin and superficial structures, the 60 millimeter, 20 gauge needle is now forced into the skin in the center of the triangle. (See Figs. 242, 243, and 244.) The needle is now forced upward, inward, and backward, carrying it at an angle of 40 degrees. The 40 degree angle is calculated from the horizontal line. After the needle has been forced into the tissue in the direction outlined above to a depth of approximately 2½ cm., the needle should be worked back and forth slightly, at the same time extending the syringe laterally (see Fig. 245) until the point of the needle comes in contact with the posterior lateral surface of the tuber maxillare, and after it passes this point the needle will suddenly pass into the sphenomaxillary fossa. When this part of the superior maxillary bone is reached by the needle, it proves that the needle is proceeding in the proper direction. (See Figs. 246 and 247.) The bevel of the needle should be towards the bone, and care should be taken not to force the needle beneath the periosteum covering the tuberosity, as it would bind the needle and make it very difficult to advance it at the proper angle. After this bony prominence has been reached, the needle is advanced into the sphenomaxillary fossa (pterygopalatine) at an approximate depth of five

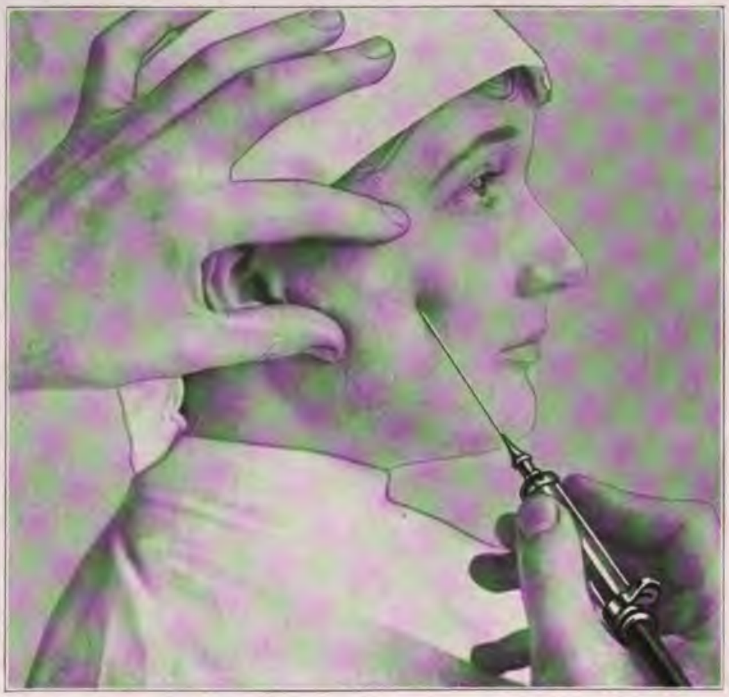


Fig. 244.—The needle employed for blocking the second division by the extraoral method enters the skin (which has been previously anesthetized by a preliminary injection) at point marked X within the triangle. (See Fig. 242.)

centimeters. The point of the needle should assume a position midway between the posterior portion of the floor of the orbit and the foramen rotundum. The needle should strike the anterior surface of the sphenoid bone in the region of the foramen rotundum at an approximate depth of $5\frac{1}{2}$ cm. If the needle does not strike the anterior surface of the greater wing of the sphenoid bone after it has been inserted into the tissue at a depth of $5\frac{1}{2}$ cm., it should be withdrawn a short distance and made to take a more backward course.

In some cases the needle may assume a too backward or lateral course, and in this event the needle will strike the anterior surface of the external pterygoid plate, and, should it do so, the needle is withdrawn a short distance, and then is slowly advanced forward until it passes over the anterior margin of the external pterygoid plate, and after it passes this margin of bone it should be forced upward, backward and inward, carrying the needle at an angle of 40 degrees to a depth of 1 cm., that is, after the anterior surface of the external pterygoid plate has been passed. If this is carefully done, the point of the needle should be located in contact with the second division after it emerges from the foramen rotundum.

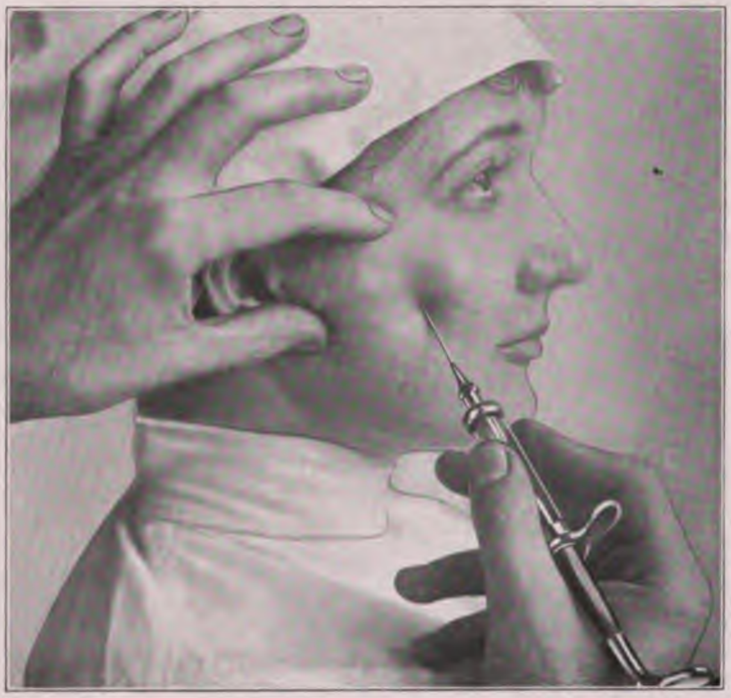


Fig. 245.—Position of needle as it is advanced upward, inward, and backward at an angle of 40 degrees, which is calculated from the horizontal line. At an approximate depth of $2\frac{1}{2}$ centimeters the bevel of needle should be in contact with the posterior lateral surface of the maxillary tuberosity.

Another technic, which is efficient, is to advance the needle in the direction described above to a depth of $2\frac{1}{2}$ cm., and at this depth the bevel of the needle is allowed to come in contact with the periosteum covering the posterior-lateral curvature of the superior maxillary bone. (See Figs. 245, 246, and 247.) This is accomplished by working the needle back and forth and at the same time extending the syringe laterally, when the needle is at a depth of 2½ cm. After this has been done, the needle is advanced along the periosteum in an inward, upward and backward direction to a depth of 2½ cm. (See Figs. 248, 249, 250, 251, and 252.) The total depth of the needle from the skin surface is approximately 5 cm. (50 mm.). If the operator is in doubt as to whether or not the point of the needle is located near or in contact with the nerve trunk, the needle can be manipulated slightly, and when it comes in contact with the nerve, the patient will have the characteristic signs of paresthesia in the various nerve branches, such as radiating impulses on the face.

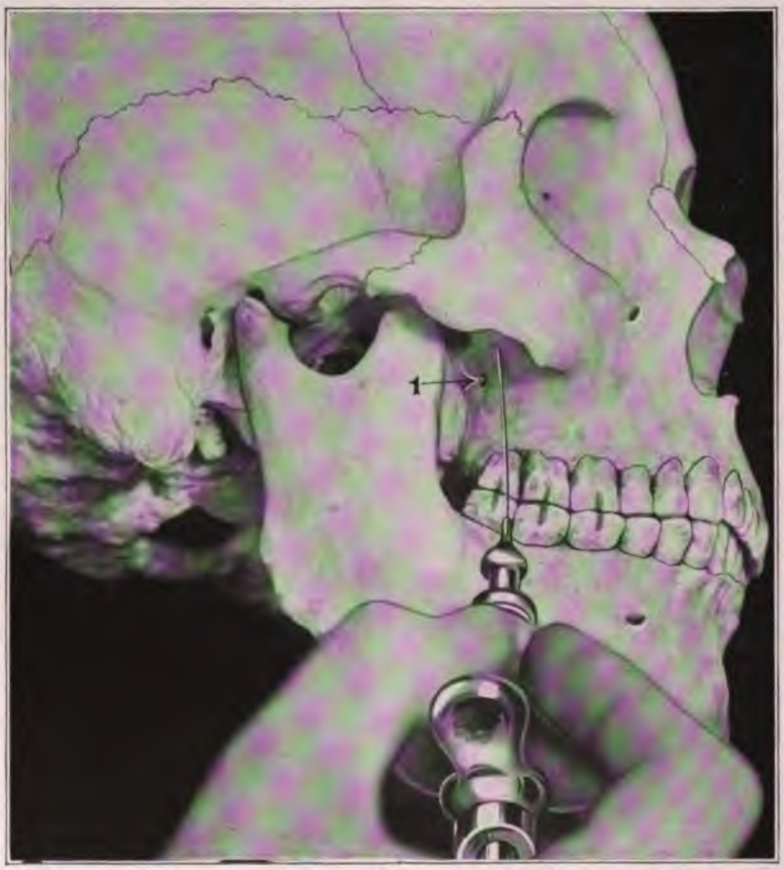


Fig. 246.—Lateral view of skull showing the region of tuberosity which is reached by the needle at an approximate depth of 2½ centimeters. 1, posterior superior dental foramen.

Injection of Solution.—The quantity of solution injected for the blocking of the second division of the fifth nerve by the extraoral route is four mils.

A 2 per cent procain suprarenin Ringer's solution is employed. It is good practice to manipulate the needle back and forth through a distance of 3 to 5 mm. while the solution is being discharged into the tissues, which facilitates the solution leaving the syringe with very little pressure.

Precautions.—In case the needle is directed too high and medially, it may

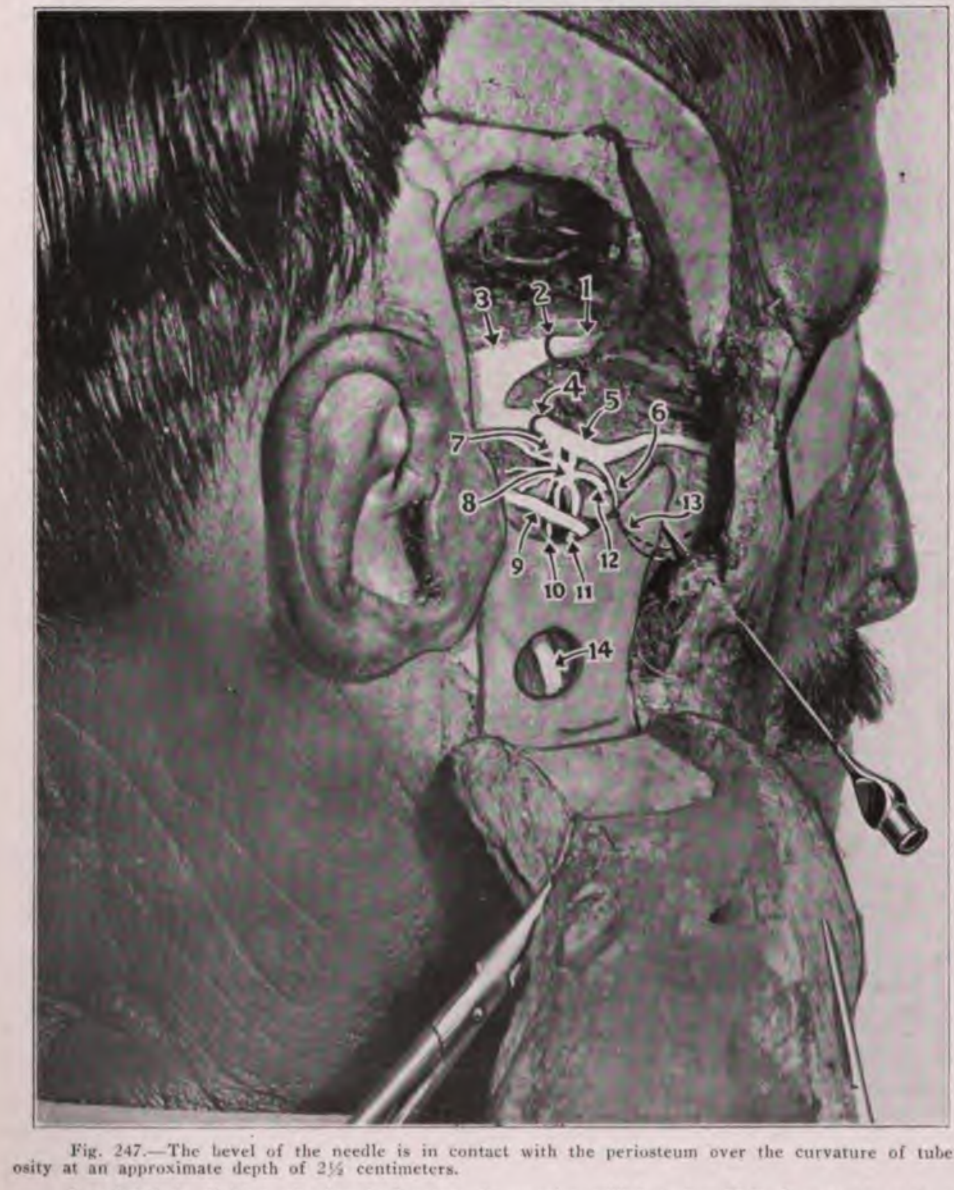


Fig. 247.—The bevel of the needle is in contact with the periosteum over the curvature of tuberosity at an approximate depth of 2½ centimeters.

1, ophthalmic division of trigeminal nerve; 2, superior orbital (sphenoidal) fissure; 3, semilunar (Gasserian) ganglion; 4, foramen rotundum; 5, maxillary division of the trigeminal nerve; 6, posterior superior alveolar nerve; 7, sphenopalatine nerves; 8, sphenopalatine (Meckel's) ganglion; 9, long buccal nerve; 10, posterior palatine nerve; 11, middle palatine nerve; 12, nasopalatine nerve; 13, posterior superior alveolar nerve; 14, inferior dental nerve.

enter the posterior part of the orbit. Therefore, after the needle has passed over the anterior surface of the external pterygoid plate, it should never be advanced farther than 1 cm. The distance from the puncture of the skin to the second division of the fifth nerve will vary from 42 to 57 mm., the average distance being 50 mm. The needle being 60 mm. in length, 10 mm. (see Fig. 248) will remain on the outside, which will act as an excellent medium of knowing the exact depth the needle has been inserted into the tissues. Another precaution which should be taken is never to advance the needle beneath the periosteum, which would prevent its insertion at the proper angle. In case the needle is advanced too far and the solution injected, partial anesthesia of one or more of the extrinsic eye muscles may occur, due to the anesthetizing solution infiltrating them. However, these symptoms are only temporary and disappear with the anesthesia, and normal function is soon restored.

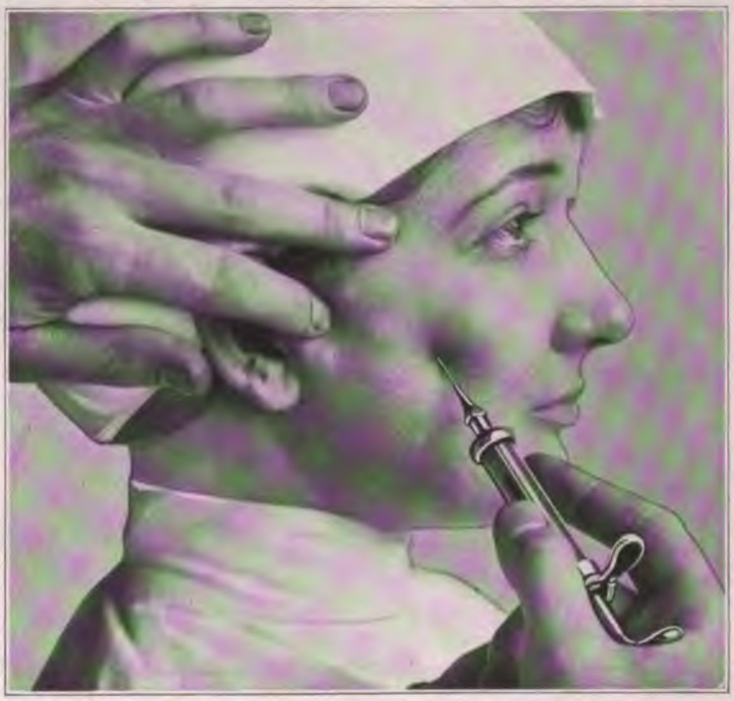


Fig. 248.—After the bevel of needle has reached the periosteum of posterior lateral tuberosity at an approximate depth of 2½ centimeters (see Figs. 246 and 247) the needle is advanced along the periosteum towards the second division in an upward, inward, and slightly backward direction (see Figs. 249, 251 and 252) 2½ centimeters, making a total depth of 5 centimeters.

Time to Wait for Anesthesia.—Ample time should be allowed following this injection, in order to permit the solution to permeate the sensory fibers which make up this large nerve trunk. The diameter of this nerve as it crosses the sphenomaxillary fossa (pterygopalatine fossa) is from 3 to 5 mm., and it requires from 10 to 20 minutes for the anesthetizing solution to thoroughly permeate a nerve of this size. Many an operator has failed to secure the best results because ample time was not allowed for the anesthetic to produce profound anesthesia before the operation was begun.

Structures Anesthetized.—The blocking of the second division of the fifth nerve produces a large area of anesthesia. (See Fig. 253.) All branches

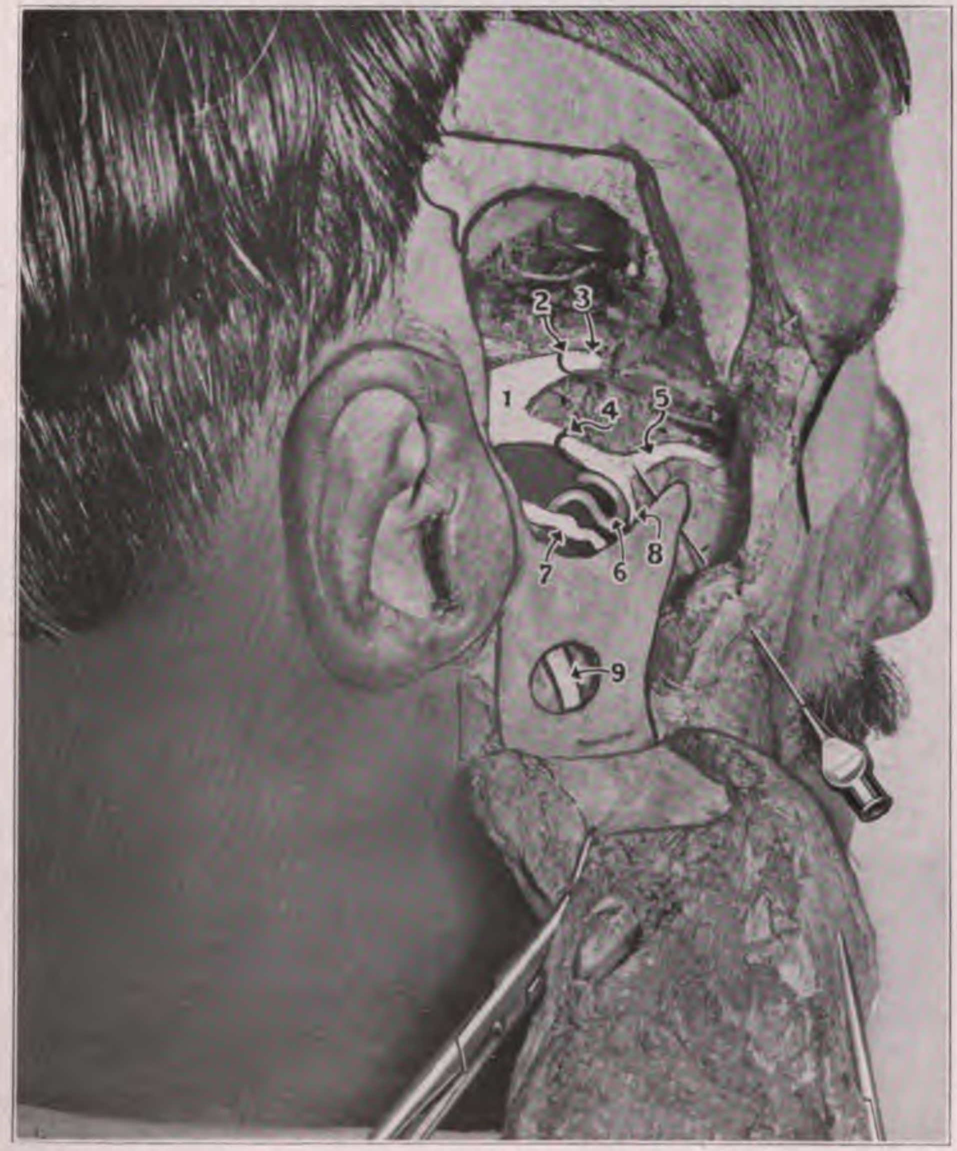


Fig. 249.—Illustrating the position of needle and its relationship to anatomical structures for blocking the second division.

Approximately 2½ centimeters of the needle are in contact with the periosteum, while 2½ centimeters are located in the soft tissues lateral to tuberosity.

1, semilunar (Gasserian) ganglion; 2, superior orbital (sphenoidal) fissure; 3, ophthalmic division of trigeminal nerve; 4, foramen rotundum; 5, maxillary division of trigeminal nerve; 6, internal maxillary artery; 7, long buccal nerve; 8, posterior superior dental nerve; 9, inferior dental nerve.

which are given off the second division anterior to the point of injection are blocked, and in addition, Meckel's ganglion and its branches are usually anesthetized. The reader should be impressed with the fact that the solution is deposited at the same point by both the intraoral and extraoral methods; therefore, there is no difference as to the structures anesthetized or the nerve branches which are blocked. (See page 391 under the heading of "Structures Anesthetized" by the intraoral method.)

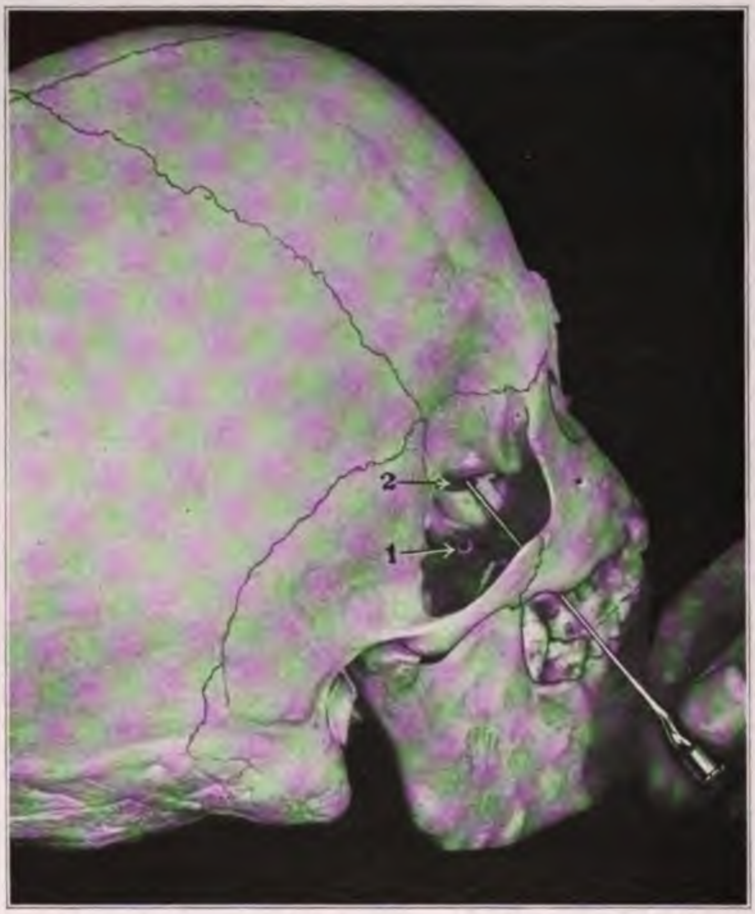


Fig. 250.—Posterior lateral view of skull illustrating the needle in contact with the second division of fifth nerve. Note that the needle is located a considerable distance anterior to the posterior superior dental foramen.

1, posterior superior dental foramen; 2, second division of fifth nerve crossing sphenomaxillary fossa.

Anesthesia cannot be secured to the median line on the side of injection because the fibers of the second division on the opposite side overlap and communicate in the region of the median line with the fibers of the second division on the side of injection. If it is desired to obtain anesthesia of the tissues to the median line on the side of injection, it is essential to block these communicating interlacing fibers by either making an intraosseous injection or by blocking the anterior superior alveolar and terminal branches of the infraorbital nerve at the infraorbital foramen. (For complete technic see "Blocking the Interlacing or Overlapping Branches," page 392.)

The second division on both the right and left sides should be blocked if the nature of the operation warrants it.

Examples of surgical cases in which both sides should be blocked would be fracture of the superior maxillary bone, gunshot wounds, a superior maxillary resection, or the extraction of all the teeth in the upper jaw. Following the blocking of these nerve trunks, anesthesia will be obtained in the greater portion of the superior maxillary bones, part of the palate bones, the greater part of the nasal septum, antra of Highmore, all the upper teeth and alveolar process, palate, portion of the cheek, lips, cartilage of nose and other structures. If the reader is thoroughly familiar with the branches of the fifth cranial nerve he should know immediately what tissues will be anesthetized following any block injection.

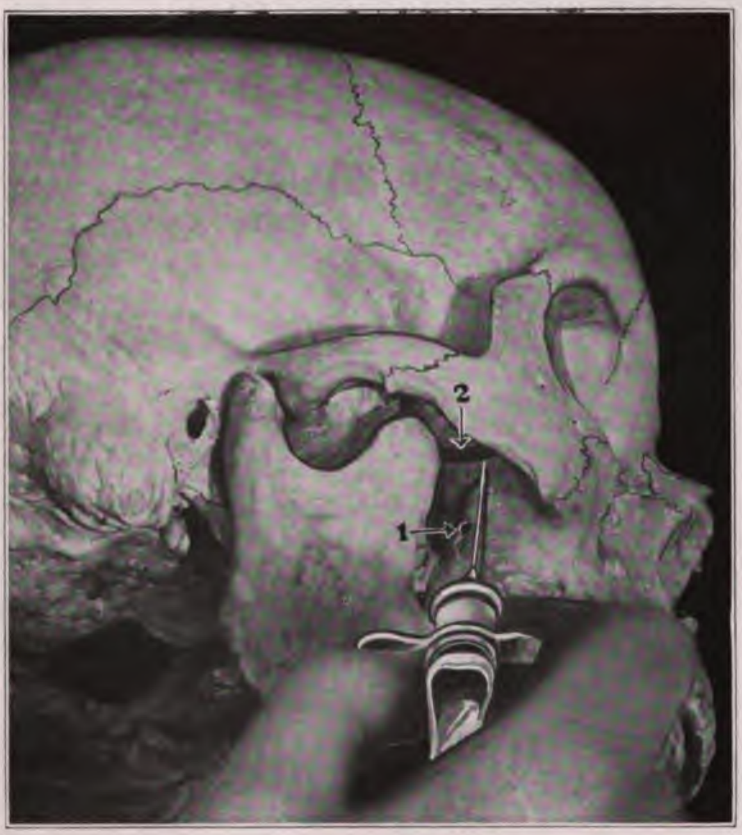


Fig. 251.—Lateral view of skull showing the point of needle in contact with the second division of the fifth nerve. The direction of the needle is upward, inward, and slightly backward.

1, posterior superior dental foramen; 2, second division of fifth nerve crossing sphenomaxillary fossa.

BLOCKING THE SECOND OR MAXILLARY DIVISION OF THE FIFTH NERVE BY THE ORBITAL ROUTE

Osteology of the Orbit.—Before discussing the technic of blocking the second division by the orbital route, it is necessary to discuss briefly the osteology of the orbit. Each orbit is a quadrilateral prismatic space which has the shape of a horizontal pyramid, (see Figs. 32, 35, 39, 55, and 62) the apex of which is situated posteriorly to the region of the optic foramen. The base of the pyramid is a quadrangle with rounded corners, and forms the entrance to the orbital cavity. The walls of the orbit are designated as superior, internal, external, and inferior. The upper wall or roof is formed by the orbital portion of the frontal bone anteriorly, and by the lesser wing of the sphenoid bone posteriorly. Its surface is slightly concave, horizontal and smooth. The roof is triangular in shape and from the orbital margin its course is first upward, then downward, backward and inward. It contains the lachrymal fossa which is located at its outer angle for the reception of the lachrymal gland. At the inner angle is located a depression for the pulley of the superior oblique muscle. Anterior to this point, at the junction of the inner second and third fifths of the upper circumference is located the supraorbital notch or foramen which transmits the supraorbital artery, vein and nerve.

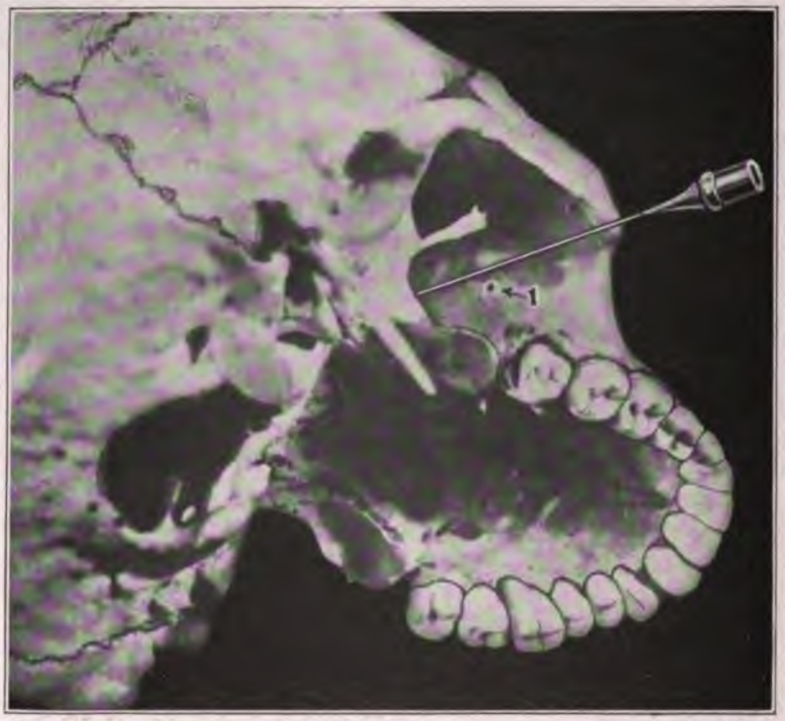


Fig. 252.—Lower lateral posterior view of maxillary tuberosity, showing that portion of the needle which should be in contact with the periosteum. 1, posterior superior dental foramen.

The inner wall of the orbit is formed by the nasal process of the superior maxillary bone, the lachrymal bone, the os planum of the ethmoid, and the body of the sphenoid. Posterior to the lachrymal groove this wall presents a smooth, yet irregular, slightly convex surface which assumes almost a directly backward position. Situated at the junction of the superior wall or roof and the inner wall between the ethmoid and frontal bones, which form a suture, are located the posterior and anterior ethmoidal foramina. The anterior foramen is located one-half the depth of the orbital wall, while the posterior foramen is located about midway between the orbital foramen and the anterior ethmoidal foramen. The anterior foramen transmits the nasal nerve and ethmoidal vessels, while the posterior foramen transmits the posterior ethmoidal vessels.

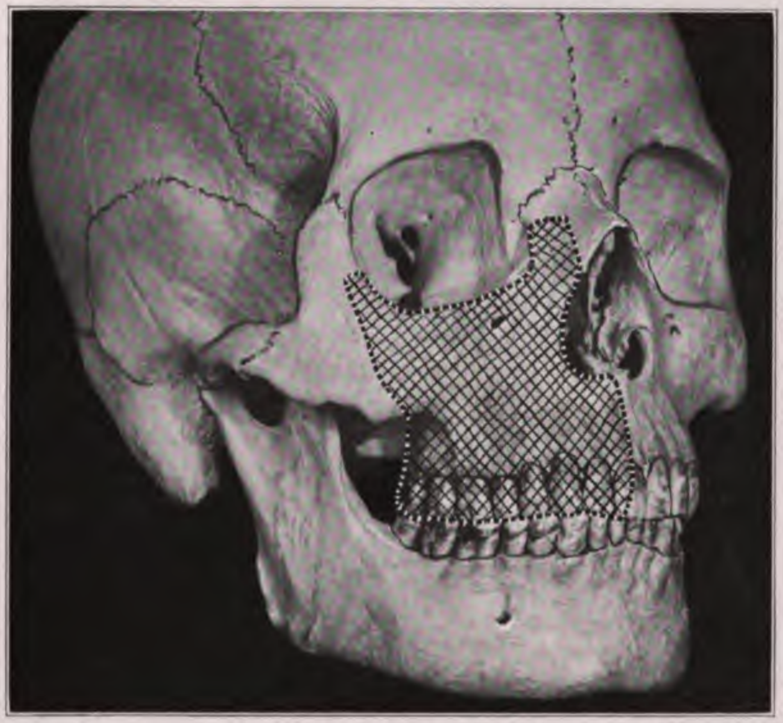


Fig. 253.—Area of tissue anesthetized following the blocking of the second division of the fifth nerve, provided the overlapping or interlacing branches are blocked.

The floor of the orbit is nearly flat and is divided posteriorly by the inferior orbital (sphenomaxillary) fissure. (See Figs. 39 and 257.) The greater portion of the floor of the orbit is composed of the orbital surface of the superior maxillary bone. However, a small portion is formed by the orbital process of the palate bone. In the extreme anterior portion of the orbit the malar bone forms a narrow strip of the floor. The orbital floor is quite smooth, sloping laterally and anteriorly. In its central part it is slightly convex, but near the orbital margin it is concave. In this region the bone is quite thin and forms the roof of the maxillary sinus.

The outer wall of the orbit is the most isolated of all and is formed by the orbital process of the malar bone and the greater wing of the sphenoid. It presents the spheno-malar suture and the orifices of the malar canals. The outer wall presents a more or less smooth surface which is concave and assumes an almost backward and inward position toward the sphenoidal fissure. The inferior orbital (sphenomaxillary) fissure separates more than half the length of the outer wall from the floor and one-third of its extent is separated from the roof by the superior orbital (sphenoidal) fissure. The outer wall is practically formed by the orbital surface of the greater wing

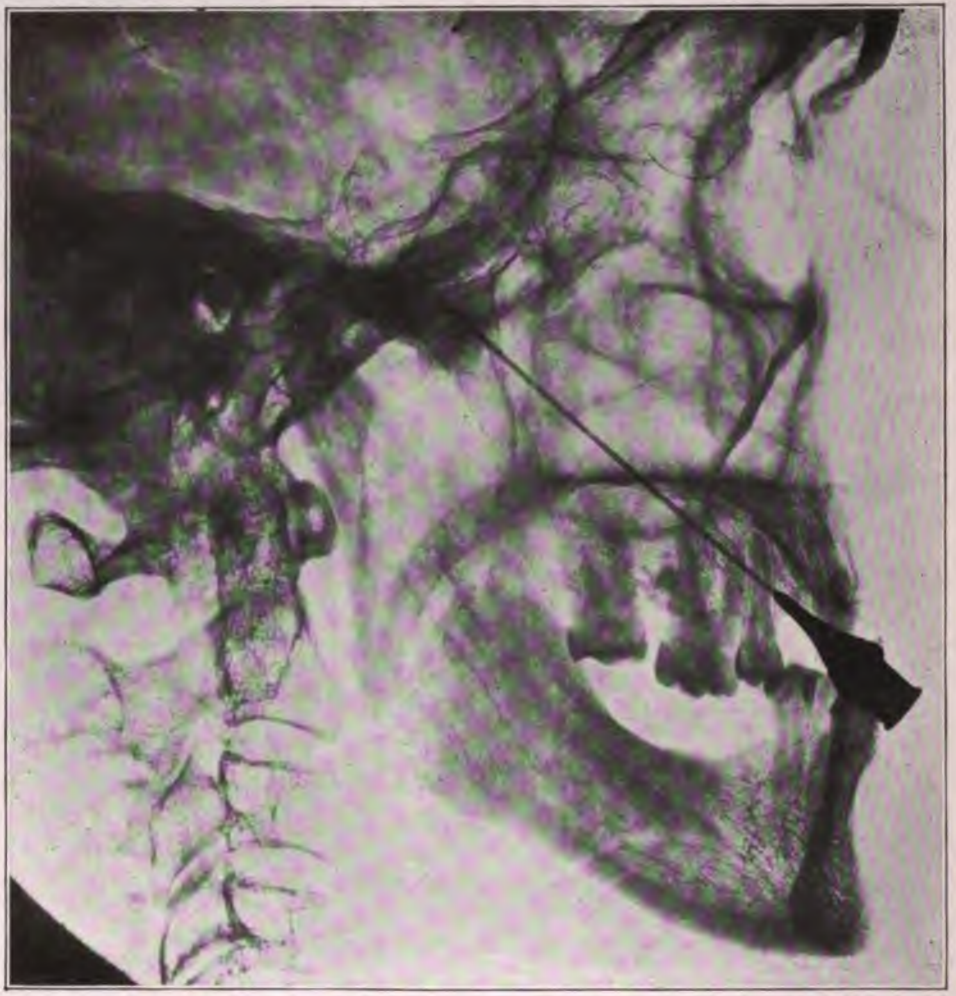


Fig. 254.—X-ray plate, which shows the position of the needle for blocking the second division of fifth nerve by the extraoral route.

of the sphenoid bone which is located in the posterior region, and the orbital surface of the zygomatic bone, which is located anteriorly. However, in the anterior region a small portion is formed by the frontal bone which extends downward from the roof. The outer wall is slightly concave and assumes an almost vertical position, but is directed somewhat from above, downward, and from without, inward. The sphenomaxillary fissure is located between the maxilla and the orbital process of the palate bone on one side, and the greater wing of the sphenoid and the malar bone on the other. It opens into the outer and back part of the orbit; it transmits the second division of the fifth nerve and its orbital branch, infraorbital vessels, and the ascending branches from Meckel's ganglion. This fissure at its internal extremity joins the pterygomaxillary fissure at right angles. It is through this fissure that three fossæ communicate, which are as follows:

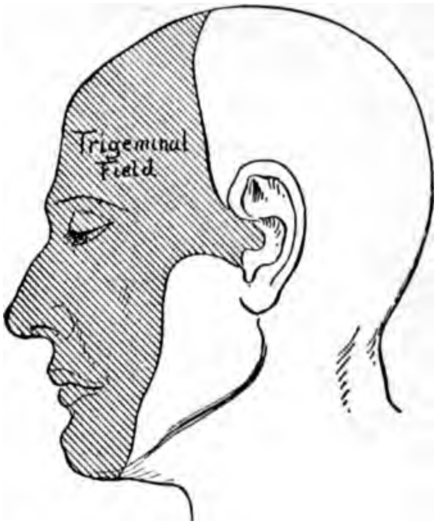


Fig. 255.—Diagram showing area of distribution of the sensory fibers of the trigeminal nerve. (From Howell's Physiology.)

1. The orbital, in front.
2. Sphenomaxillary, behind and internally.
3. The temporal, laterally and behind.

The sphenomaxillary fissure transmits the second or superior maxillary division of the fifth nerve, its orbital branch, infraorbital vessels as well as the ascending branches from Meckel's ganglion. The apex of the orbital fossa presents for examination the orbital foramen, and located externally and below this foramen is situated the foramen lacerum anterius, or sphenoidal fissure which is formed medially by the body of the sphenoid bone, superiorly and medially by the lesser wing of the sphenoid bone and inferiorly and laterally by the greater wing of the sphenoid. The sphenoidal fissure transmits the third and fourth cranial nerves, the first, or ophthalmic division of the fifth nerve, which is divided up into the lachrymal, frontal, and nasal branches, the sixth cranial nerve, the orbital branch of the middle meningeal artery, ophthalmic vein, and the recurrent branch from the lachrymal artery.

When deep nerve blocking injections are made with the intention of blocking the first or ophthalmic division, or second or superior maxillary divisions of the fifth nerve by the orbital route, an endeavor should be made to always force the needle along a definite route where the bone is smooth. The bony surfaces are used as a guide to direct the needle to the desired location. The point of the needle should always be kept in contact with the periosteum and in a zone external to the extrinsic eye muscles. The blocking of the ophthalmic or second divisions of the fifth nerve by means of the orbital route, may seem to the inexperienced operator a dangerous procedure. This is an entirely erroneous idea.

The object of the writer in discussing the osteology of the orbit is to acquaint the reader with the various bony landmarks before the technic of the deep injections is discussed.

BLOCKING THE SECOND DIVISION OF THE FIFTH NERVE BY THE ORBITAL ROUTE—MATAS' METHOD

Matas was first to present the technic for blocking the second division of the fifth nerve by inserting the needle through the orbit. Certain parts of the surface osteology must be considered, giving the technic, before inserting the needle into the region of the foramen rotundum for the purpose of blocking the second division. When we observe the apex of the orbital cavity upon the skull we note the optic foramen, the sphenoidal fissure, and beneath these two landmarks are found the anterior wall of the pterygoid process. The foramen rotundum is situated just beneath the sphenoidal fissure and transmits the second division of the fifth nerve. This large nerve passes anteriorly across the sphenomaxillary fossa and enters the sphenomaxillary fissure, and then the infraorbital canal. The nerve passes anteriorly through the infraorbital sulcus and enters the infraorbital canal, making its exit upon the face through the infraorbital foramen.

Needles Employed.—Two needles are employed for this injection. Needle No. 7, which is 27 gauge, 10 mm. long, iridio-platinum is used for the preliminary injection followed by needle No. 8, which is 21 gauge and 60 mm. long. (See Fig. 177.)

Technic of Injection.—After the skin has been aseptically prepared, a preliminary injection is made with the small, fine sharp needle, injecting at least one mil of solution. The skin is now punctured with the long nerve blocking needle at the external-inferior angle of the orbit. (See Fig. 256.) The needle is now carried over the inner rounded border of the outer infraorbital margin which is composed of the malar bone. The bevel of the needle must be kept in close contact with the periosteum covering the bone in the floor of the orbit. The needle is now carried downward and backward between the outer and lower angles of the orbit through a distance of 1 cm. from the rounded portion of the infraorbital margin. This particular point of the bone is concave, which is easily detected with the point of the needle. At the depth of 1 cm. the needle is gently worked backward and inward, and it will be found that the point will ascend, due to the shape of the infraorbital floor. The needle is now advanced with the bevel along the periosteum inferiorly, medially, and posteriorly, and in most cases, the needle will assume an angle of 25 degrees. The needle is advanced in the above described direction along the floor of the orbit until the inferior orbital (sphenomaxillary) fissure is reached. The inner margin of the malar bone, which forms the outer aspect of the inferior orbital fissure is reached by the needle at a depth of 2 cm. in most cases. (See Fig. 257.) This margin is easily detected with the point of the needle by the operator who is familiar with the anatomy of the parts involved. After this landmark has been observed, the needle is advanced backward, medially and slightly upward through the inferior orbital tissue another 2 cm., making a total depth of four centimeters, and at this depth the anterior superior surface of the planum pterygoideum, located upon the anterior surface of the sphenoid bone, should be reached. After the anterior surface of the planum pterygoideum has been reached, the needle is gently advanced 1 cm. backward, medially and upward along the periosteum, which is in the direction of the foramen rotundum. The dis-

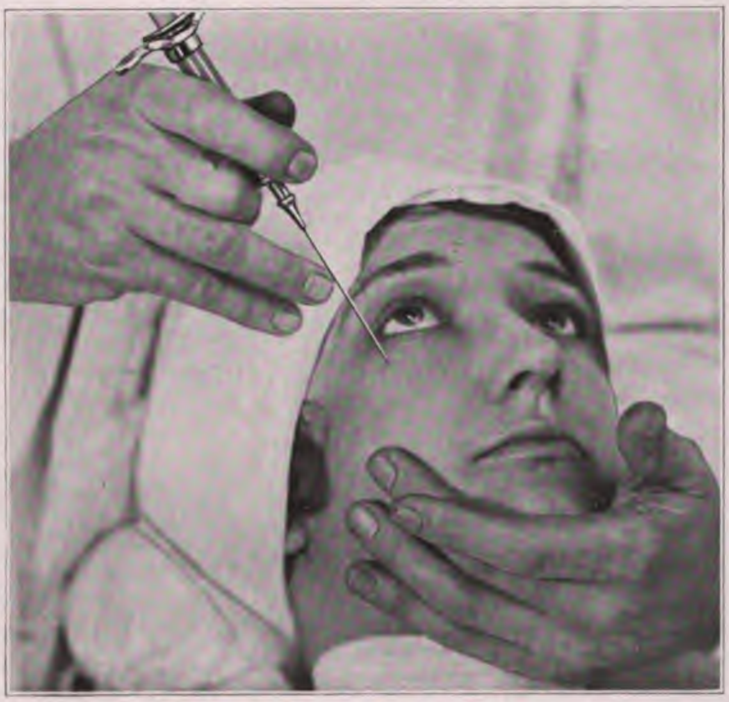


Fig. 256.—Blocking the second division of fifth nerve by the orbital route. The puncture of the skin is made at the external inferior angle of the infraorbital margin.

tance from the skin surface over the infraorbital margin to the foramen rotundum by the route through which the needle is inserted is 5½ cm. in the average case. The total average depth of the needle for this injection is 5 cm. Therefore, the solution in most cases is discharged at a point approximately 5 mm. anterior to the foramen rotundum. The needle employed being 60 mm. in length, 10 mm. will remain external to the skin surface.

Injection of Solution.—The same quantity of solution is employed here as is used by the intra- and extra-oral routes, which is 4 mils of a 2 per cent strength. Usually from one-half to one mil is deposited as the needle advances through the tissue until the desired location has been reached, after which the remainder, which is three or three and a half mils, is slowly injected in the region of the nerve trunk. In addition to the above, usually one mil is injected into the skin and subcutaneous tissue with a fine sharp needle. This is called the preliminary injection.

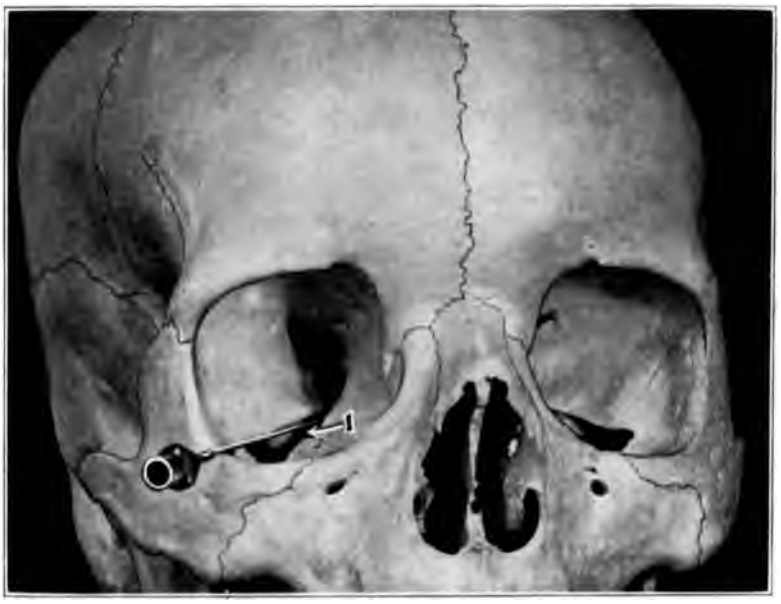


Fig. 257.—Blocking the second division of the fifth nerve by the orbital route. 1, interior orbital fissure.

Structures Anesthetized.—Anesthesia of all branches of the second division which are given off distal to the point of injection is secured. (For a complete list of the structures anesthetized, the reader is referred to "Structures Anesthetized" by the intraoral method on page 391.)

Precautions.—While inserting the needle, the following points should always be observed:

It will be found upon examination of many skulls that in some the inferior orbital fissure (sphenomaxillary fissure) is narrow and tortuous. In such cases it is rather difficult or may be impossible to insert the needle, as previously described, through the fissure in order to reach the desired location anterior to the foramen rotundum. The author has examined a large number of skulls and with practical experience in a number of cases and in at least 10 per cent of the cases, the inferior orbital fissure is narrow or tortuous which gives considerable difficulty or prevents the correct insertion of the needle as previously outlined. When the point of the needle is in close proximity to the foramen rotundum, it will enter firm connective tissue and epineurium. After the operator has made this injection a few times, his tactile sense will tell him the moment the point of the needle enters this dense connective tissue.

While blocking the second division by the orbital route, the operator must always have in mind the exact location of the foramen rotundum, which is beneath the superior orbital fissure (sphenoidal fissure). (See Figs. 39, 55, and 61.) This foramen is located beneath the floor of the orbit and is concealed from view. If the needle is inserted towards the apex of the orbital cavity without entering the inferior orbital fissure, it would meet with no bony resistance and would pass into the superior orbital fissure, and, if advanced posteriorly, the cranial cavity would be entered. If no bony resistance is encountered, the needle should be carefully retracted and directing it downward, it is again inserted so as to come in contact with the planum pterygoideum, and is then advanced in the direction stated.

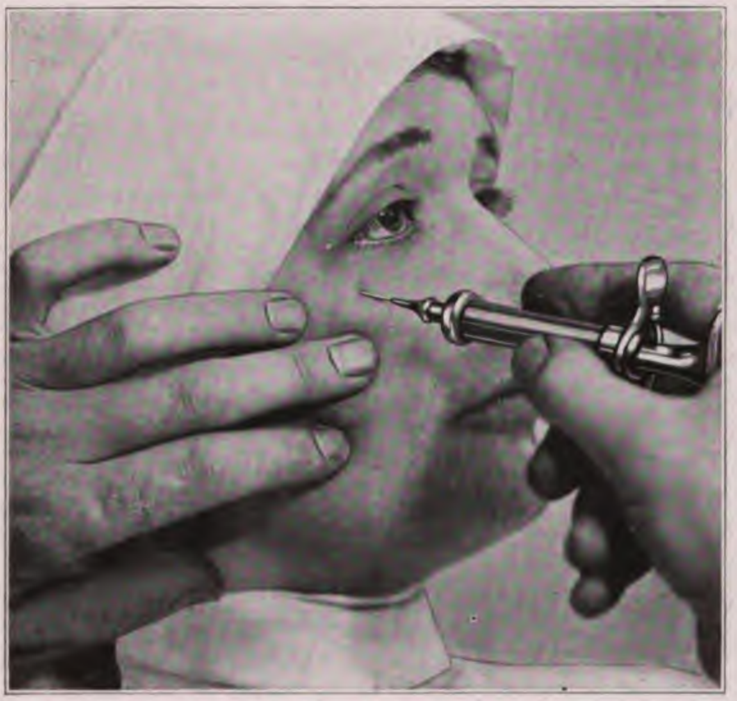


Fig. 258.—Needle in position while injecting the solution for blocking the second division of the fifth nerve by the orbital route.

The periosteum should be carefully followed by forcing the needle into the region of the inferior orbital fissure in order to avoid injuring any of the orbital contents. Care should also be exercised to direct the needle slightly upward as soon as the inferior orbital fissure is reached, for, if an upward direction is not taken, the needle will become lodged against the anterior surface of the planum pterygoideum. If the needle is carried too far laterally, the second division region will be missed, and in that case the needle should be retracted and a more inward direction taken.

If the solution is properly injected, it should not affect the ciliary nerve, optic nerve, or other structures in this region.

Time to Wait for Anesthesia.—If the needle enters the epineurium, the patient may experience paresthesia in the tissues which are supplied by the second division of the fifth nerve. Sufficient time must be allowed to permit the anesthetizing solution to thoroughly permeate the sensory fibers which compose this large nerve branch.

Soon after the anesthetic solution is injected, signs of approaching anesthesia will follow. In case the solution is not deposited in contact with the nerve trunk, twenty or tweny-five minutes' time must elapse before anesthesia is profound. If the solution is deposited in close proximity to the nerve trunk, anesthesia is profound in from ten to twenty minutes.

BLOCKING THE POSTERIOR SUPERIOR DENTAL (ALVEOLAR) NERVE

Topography of Anatomy.—For a study of the parts to be blocked, the reader is referred to Chapter VII. A detailed description of the anatomy will not be given here. However, a few remarks are essential.

The posterior superior dental nerve or nerves are given off the second division of the fifth nerve as it crosses the sphenomaxillary fossa, just before the second division enters the posterior portion of the floor of the orbital cavity. (See Figs. 48 and 65.) The posterior superior alveolar nerve may be single, (see Fig. 64) or it may be multiple (see Figs. 65 and 68) and enter as many small foramina as there are nerve branches. Gray states that, in some instances, several posterior superior alveolar or dental nerves are present. Of the numerous dissections made by the author, he has in one case found this nerve given off as one branch, and later dividing into four branches and entering from foramina in the tuberosity of the superior maxillary bone. In three dissections a single branch was found. In four dissections it was found that this nerve was given off as one branch, later dividing into two branches. For practical purposes, it makes no difference whether the nerve enters the posterior lateral tuberosity of the superior maxillary bone as one branch or several branches, because if the solution is injected in the immediate region of the foramen or foramina, rapid anesthesia will be produced. The diameter of this nerve at its origin is approximately one millimeter. Its direction is downward, laterally and anteriorly until it reaches the posterior portion of the maxillary tuberosity or zygomatic process, and at a point approximately

2 cm. above the distogingival margin of the upper third molar it enters the foramen of the same name. (See Figs. 36, 40, and 60.)

In brief, this nerve supplies the posterior lateral tuberosity, the alveolar process, upper second and third molars, buccal periosteum, gum tissue, and mucous membrane. It communicates with the middle superior alveolar over the upper first molar and second bicuspid teeth. (See Figs. 40 and 60.)

The osteology of the tuberosity of the superior maxillary bone should not be overlooked, and if the operator will observe the anterior view of a skull (see Fig. 32) he will notice that it is impossible to see the posterior superior alveolar foramen because it is located posterior to the tuberosity or, in other words, around the curvature of this bone. When the operator notices this point, he will appreciate the advantage in using a needle with the slightly curved hub (the needle itself should not be curved), in order that the needle can pass around the curvature of the tuberosity to reach the foramen which is located posteriorly and approximately 2 cm. above the distogingival margin of the upper third molar. The tissue punctured by the needle is the mucosa located midway between the gum tissue and the cheek or, in other words, the reflection of mucous membrane. The needle passes through some fibers of the buccinator muscle located posteriorly; also fibers from the external pterygoid muscle, and in addition, the needle passes through loose connective tissue.

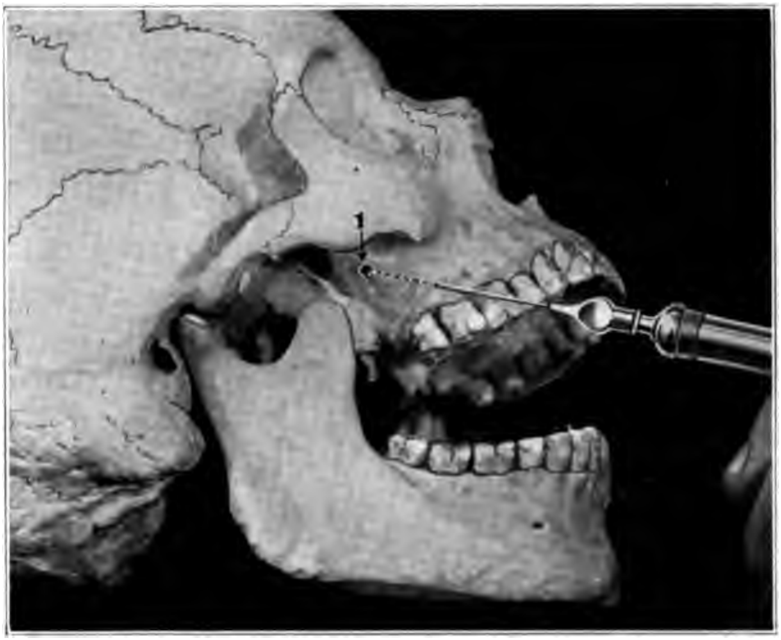
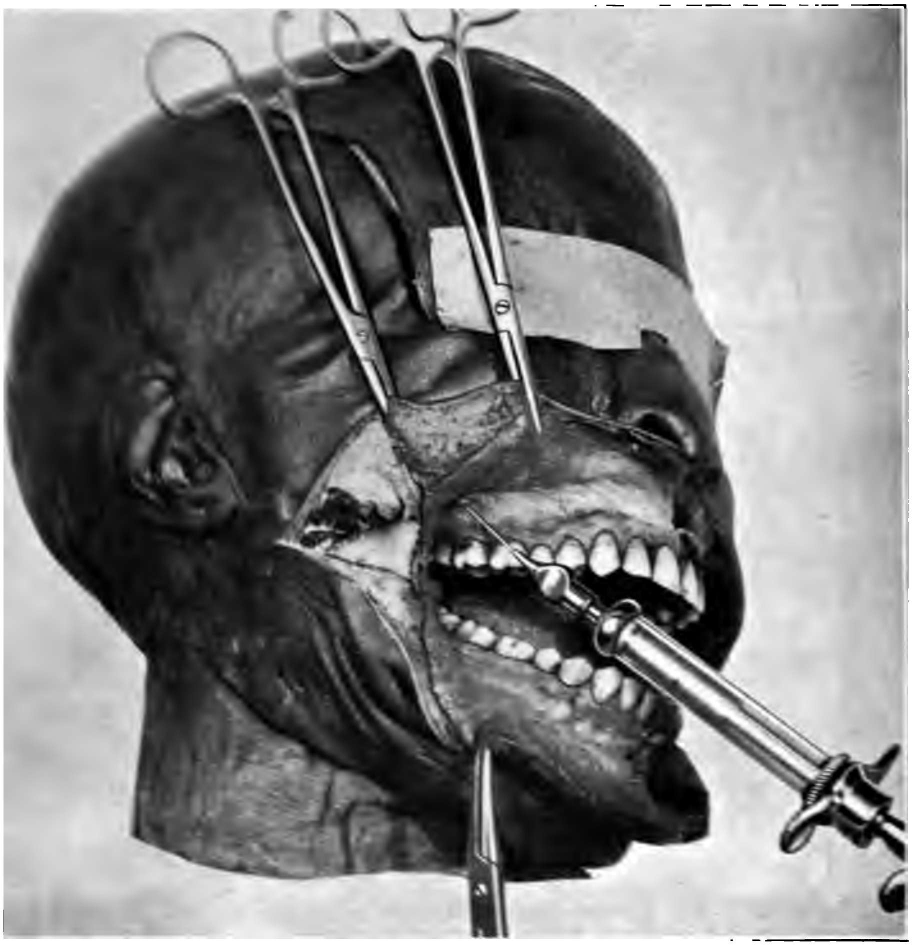


Fig. 259.– Illustrating the starting point of the needle for blocking the posterior superior dental nerve. The needle enters the mucous membrane buccal to the distobuccal root of the upper second molar and is advanced upward, backward and inward to a depth of one centimeter at which point it should reach the periosteum as illustrated in Fig. 262.

1, posterior superior dental foramen.

Needle Employed. The iridio platinum needle No. 5 which is employed for the blocking of the posterior superior alveolar nerve is 23 gauge, and [illegible] cm in length (See Fig. 177). This needle is mounted on a slightly curved hub which allows the needle to pass around the curvature of the superior [illegible] the purpose of reaching the posterior [illegible] of a hub which is slightly curved, it



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the curved hub is employed, the barrel of the syringe in most cases is held just outside of the arch, and at the same time, one cm. of the needle is in contact with the curved portion of the tuberosity.

Technic of Injection.—With the patient's mouth half open, the process of the posterior-lateral portion of the tuberosity is carefully palpated with the index finger. This is best accomplished by extending the patient's cheek laterally as much as possible, and with the index finger inserted posteriorly and internally around the curvature of the superior maxillary bone so as to ascertain the prominence of this structure. After locating the tuberosity, the area of injection is carefully prepared as described on page 355. The needle is inserted into the reflection of mucous membrane to the buccal and above the position occupied by the disto-buccal root of the upper second molar. (See Figs. 259, 260, and 261.) The barrel of the syringe should be located outside of the arch on the same side of injection (see Fig. 261). After the point of the needle enters the mucous membrane, situated between the gum tissue and cheek, it is approximately 1 cm. from the alveolar process covering the buccal portion of the disto-buccal root of the upper second molar. Figs. 259 and 262 show the needle assuming an acute angle with the process in this region. The needle is now slowly advanced upward, backward, and inward, until 1 cm. has disappeared in the soft tissue, at which

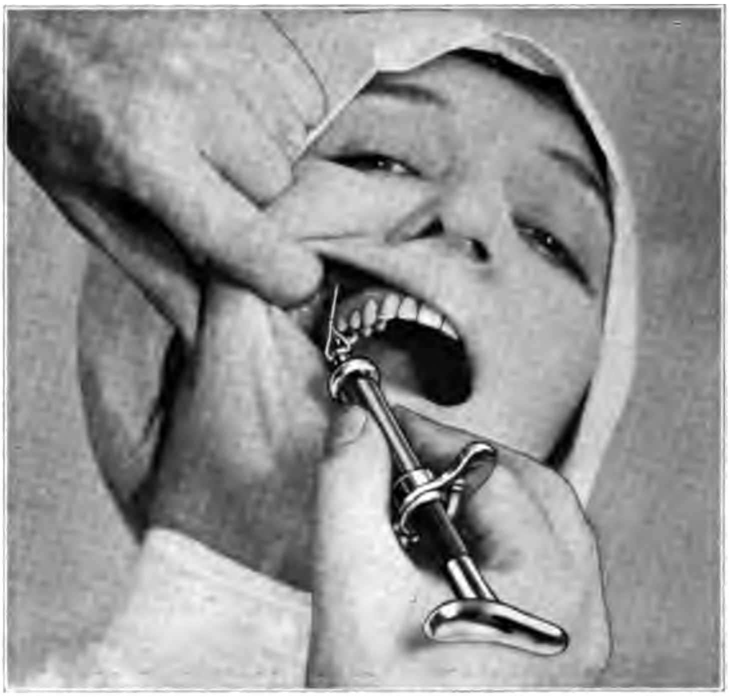


Fig. 261.—Showing correct position of syringe while making the initial puncture in the mucous membrane buccal to disto-buccal root of upper second molar for blocking the posterior superior dental nerve.

time the syringe is brought laterally and worked back and forth through a distance of 1 or 2 mm. until the periosteum covering the lateral curvature of the tuberosity is reached by the needle (see Fig. 262). The object of striking the tuberosity at this point is that the operator will know positively that the needle is in contact with the curvature of the bone, and he will not insert the needle posteriorly at random into the soft tissues, but will carry the needle backward, inward and around the curvature of the bone. (See Fig. 266.) After the lateral curvature of the tuberosity has been reached by the needle, (See Fig. 262), it is advanced another centimeter, which makes a total depth of

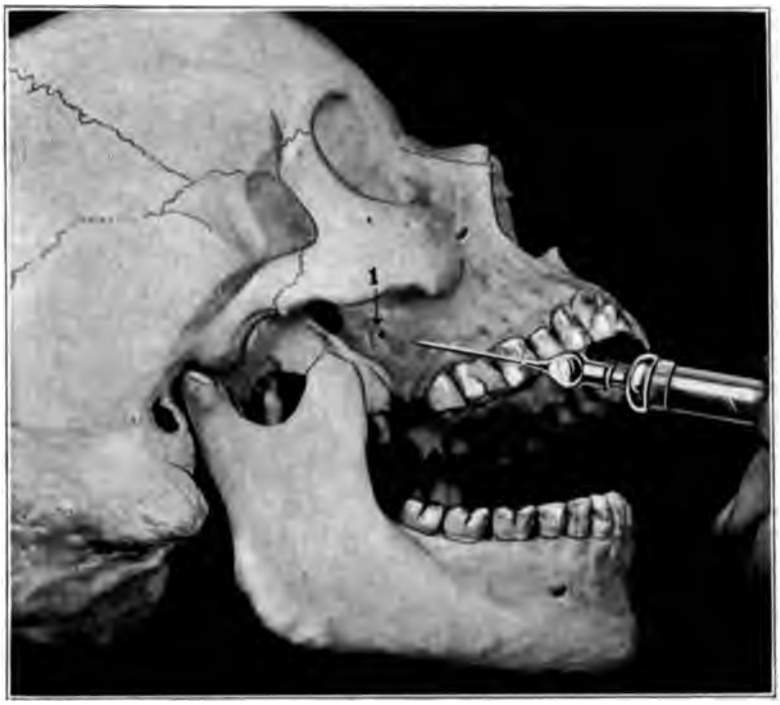


Fig. 262.—The bevel of the needle is in contact with the periosteum covering the curvature lateral to the tuberosity. The approximate depth of the needle at this time is one centimeter, and only the point is located in contact with the periosteum, while the remaining portion is situated in the mucous membrane.
1, posterior superior dental foramen.

two centimeters. (See Fig. 263.) After the point of the needle has reached the periosteum at a depth of one centimeter, it is directed upward, backward and inward at a point approximately 5 mm. above the apex of the upper third molar. At least one centimeter of the distal end of the needle should be in close contact with the periosteum covering the tuberosity (see Figs. 263 and 266) and 1 cm. situated in the loose connective tissue and mucosa. (See Figs. 260 and 261.) The approximate distance to insert the needle for this injection is two centimeters. The needle is 3 cm. in length, therefore 2 cm. are in the tissue, and 1 cm. exterior to the tissue. (See Figs. 264, 265 and 266.) Care should be taken in manipulating the syringe back and forth, when the needle is inserted into the tissue at a depth of 1 cm., to prevent the needle from becoming engaged beneath the periosteum. It is not difficult to force the needle upward, backward and inward around the curvature, so that the point will be near the posterior superior alveolar foramen (see Fig. 263) when the solution is injected. If the needle is inserted beneath the periosteum, it will be bound to the bone. Therefore, it would be difficult to advance the needle medially and around the curvature of the tuberosity. The bevel of the needle should be located towards the periosteum. After the operator has had some experience, he will have no difficulty in detecting when the needle strikes the periosteum, and in extending it to the desired location.

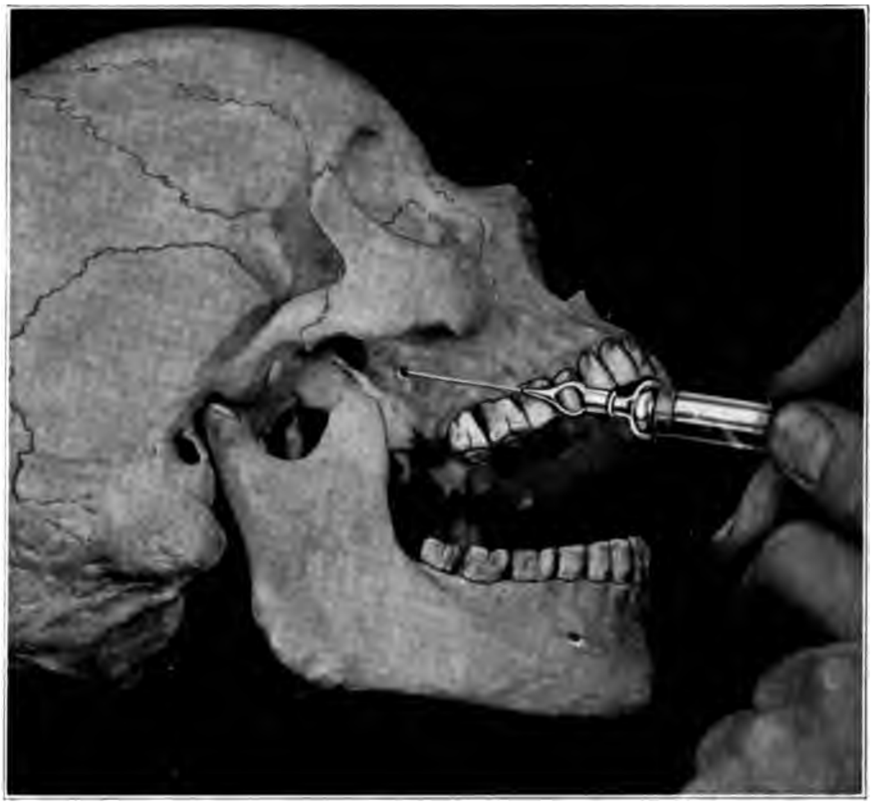


Fig. 263. –This photograph shows the needle in correct position for blocking the posterior superior dental nerve. One centimeter of the needle is in contact with the periosteum near the posterior superior dental foramen, while one centimeter of the needle is located in the soft tissues lateral to the tuberosity. The total approximate depth is two centimeters.

It will be found that the distance from the puncture point, which is to the buccal and above the apex of the disto-buccal root of the upper second molar, equals the distance from the disto-gingival margin of the upper third molar to the posterior superior alveolar foramen. The syringe is held in the right hand similar to that of holding a pen while writing. One should use the first and second fingers of the left hand to distend the patient's cheek, (see Fig. 261) and to expose the area at the point of insertion of the needle.

Injection of Solution.—The total quantity of solution injected is two mils. It is always permissible to inject the solution from the time the needle enters the tissue until the region of the superior posterior alveolar nerve is reached.

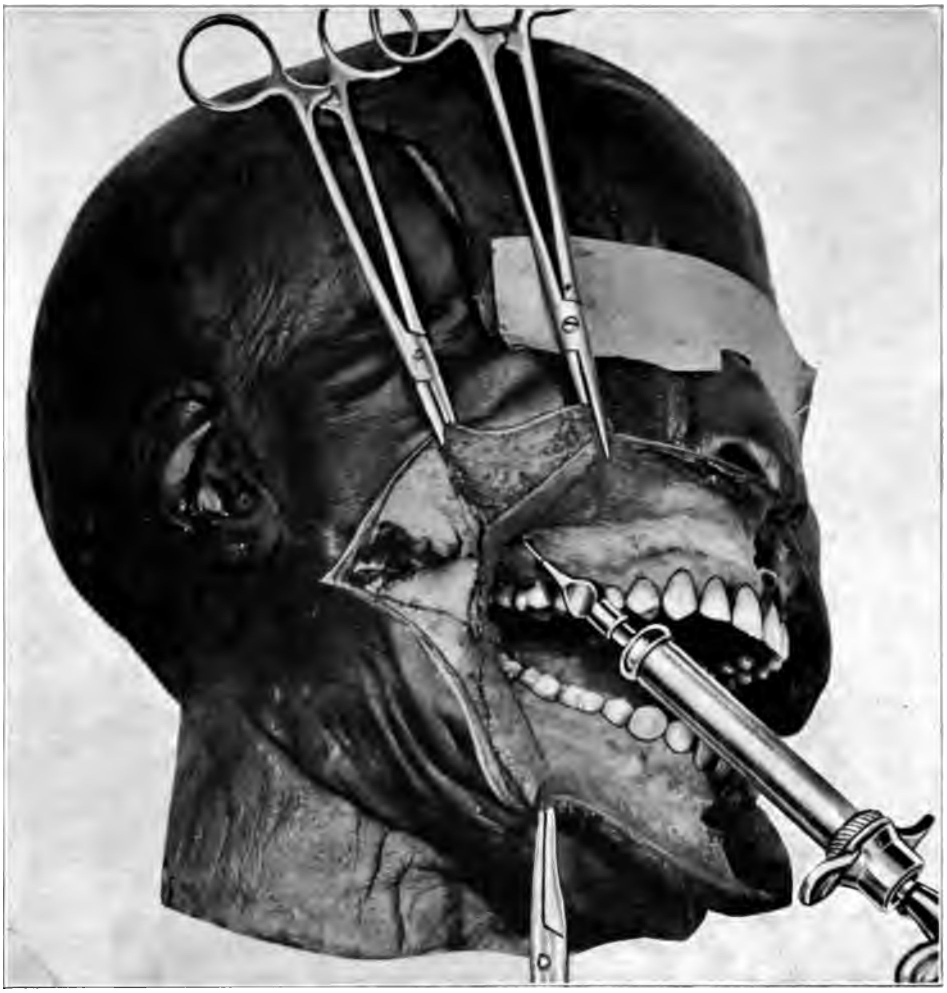


Fig. 264.—Showing the correct position of needle for blocking the posterior superior dental nerve. Its approximate depth is two centimeters and the needle point in contact with the periosteum in region of the posterior superior dental foramen.

if the patients shows the least resistance while the needle is being advanced. However, in most cases the needle is inserted without any pain whatsoever to the patient. If the patient resists in the least after the puncture has been made, inject one or two minims and wait about fifteen seconds, and then gradually advance the needle, five millimeters, and inject a few more minims and wait again, repeating this process until the needle has advanced the correct distance. With the hypersensitive individual, if the solution is given in this manner, usually one-half mil is injected while the needle is being advanced, and the remaining one and a half mils are injected to block the nerve as it enters the foramen.

Precautions.—One centimeter of the needle should be in contact with the periosteum covering the curvature of the tuberosity, which will insure rapid and deep anesthesia. (See Fig. 266.) Many operators have failed to secure anesthesia of this nerve branch because they employed a needle with a straight hub, and forced it posteriorly into the tissues. The needle inserted in this manner did not follow the curvature of the tuberosity, and when the solution was injected, the point of the needle was located at least 1 cm. laterally to the posterior superior alveolar foramen. Solutions injected in this manner will not reach the nerve branch, for the distance is too great for the solution to infiltrate through the tissues and produce a rapid and profound anesthesia. This common error accounts for many failures. It is impossible to advance a needle with a straight hub around the curvature of the tuberosity in contact with the periosteum without having the syringe assume an exaggerated lateral position. This necessitates the drawing of the patient's cheek laterally, which is not only unpleasant, but there is danger of breaking off the needle. Unless the needle is advanced in contact with the periosteum, there is a

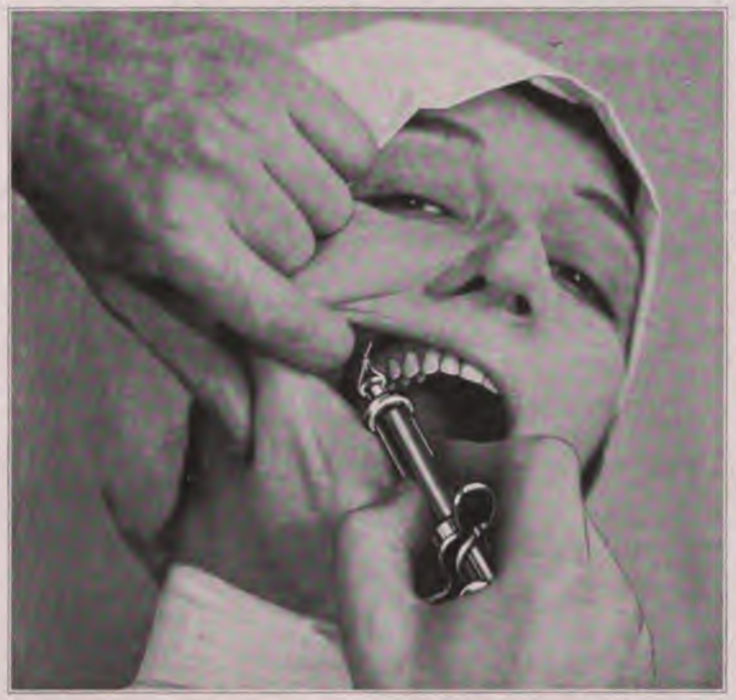


Fig. 265.—Position of syringe while injecting the solution for blocking the posterior superior dental nerve. Note that the syringe is located just outside the arch which is facilitated by employing a needle with slightly curved hub which will allow the needle to follow the curvature of the tuberosity.

possibility of injuring some of the small blood vessels located in this region, thereby producing a hematoma. The danger of producing such a condition is almost entirely avoided if the needle is kept in close contact with the curvature of the tuberosity, and by not inserting the needle too far posteriorly; and this is another reason why needles of known length should be used for making deep block injections. In case a straight hub is employed, and the needle is advanced too far posteriorly and not in contact with the tuberosity,

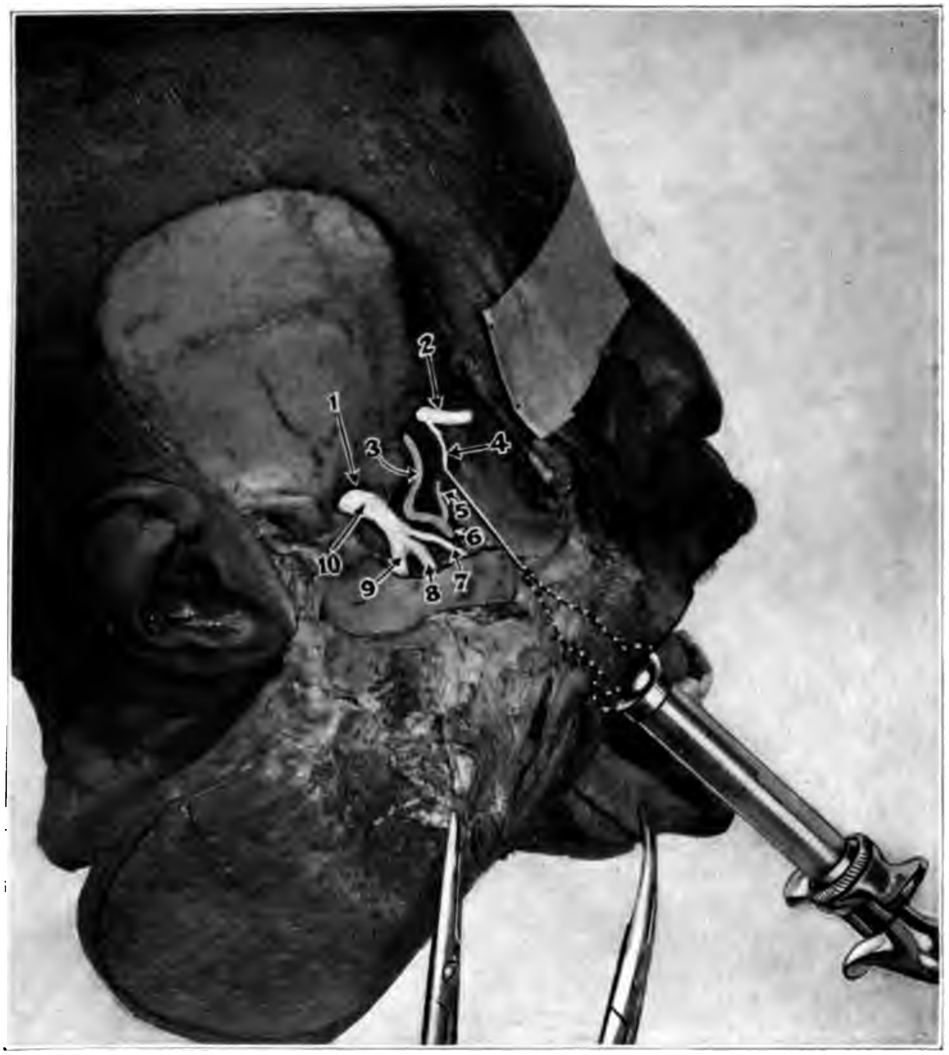


Fig. 266.—Dissected wet anatomical specimen which illustrates the needle for blocking the posterior superior dental nerve. The needle is advanced upward, backward, and inward around the curvature of the tuberosity.

1, foramen ovale; 2, second division of the fifth nerve crossing the sphenomaxillary fossa; 3, internal maxillary artery; 4, posterior superior dental nerve; 5, posterior superior dental artery; 6, internal maxillary artery; 7, long buccal nerve; 8, lingual nerve; 9, inferior dental nerve; 10, mandibular nerve.

there is some danger of the needle puncturing the internal maxillary artery. This artery is located at a distance from one-half to three-quarters of an inch posterior to the tuberosity. (See Figs. 65, 67, 122 and 266.) As previously stated, if the needle is advanced in contact with the periosteum covering the curvature of the tuberosity, possible trouble is eliminated. (A detailed description of hematoma is given on page 848.)

Time to Wait for Anesthesia.—Profound anesthesia is secured within three minutes. The author has in many cases extracted the upper second and third molars in one minute following this injection. The time to wait for anesthesia depends upon the four factors which are named on page 196. The reason anesthesia of this part is secured so quickly is because the nerves are small and the solution readily permeates them.

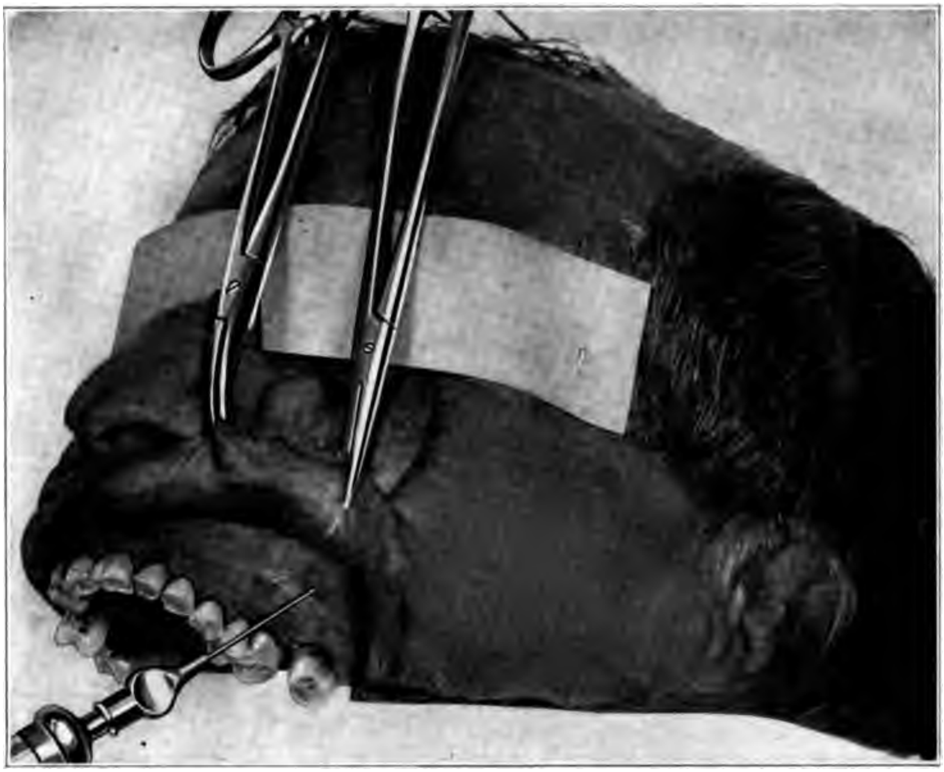


Fig. 267.—Starting the needle in the mucous membrane for blocking the posterior superior dental nerve on left side.

Structures Anesthetized.—The tissues which are anesthetized following this injection are as follows: Upper second and third molar teeth, a portion of the superior maxillary tuberosity, alveolar process, buccal gum tissue covering the upper second and third molars, buccal periosteum, and the mucous membrane of the cheek and gum tissue. (See Fig. 271.) It has been the experience of the author to anesthetize the upper first molar by this injection in approximately 5 per cent of cases, and this is accounted for by the fact that in these cases the posterior superior dental nerve supplies the upper first molar, while in 95 per cent of cases the upper first molar is supplied by both the posterior and middle superior alveolar. In a large number of cases partial anesthesia is secured in the upper first molar, which can be accounted for by the fact that this tooth receives its nerve supply from both the posterior and middle superior dental nerves. (See Figs. 40 and 60.) One root of the upper first molar may be supplied from the posterior superior dental, while the other two receive their nerve supply from the middle superior dental. The partial anesthesia secured is not sufficient for operative work. Inasmuch as the upper first molar is blocked in a small percentage of cases following the posterior superior dental injection, the author does not depend upon this injection for the anesthetization of this tooth, but employs more practical methods for anesthetizing the upper first molar. Some operators have informed the writer that in a few cases they were able to block the upper first molar together with the upper second and third molars by a posterior superior dental injection, but in many cases they had failed to do so. The explanation for the successful outcome in some cases and failure in others is that the nerve supply to the upper first molar

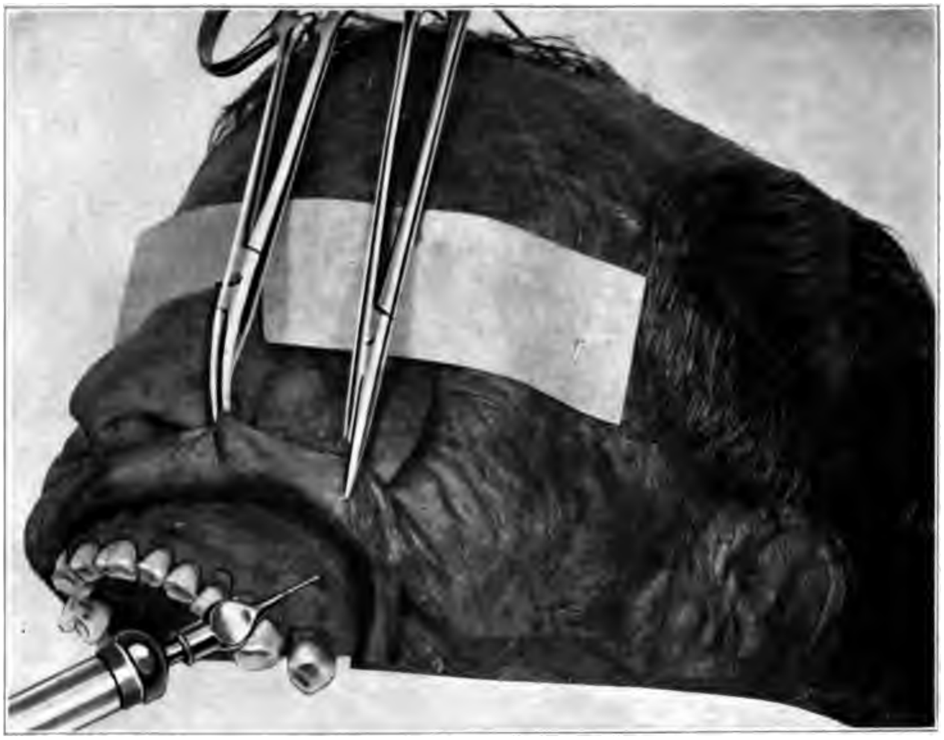


Fig. 268.—Showing correct position of needle for blocking the posterior superior dental on the left side. Approximately one centimeter of the needle is allowed to remain exterior to the puncture point, while approximately two centimeters are situated within the tissue.

is not definite. This injection does not anesthetize the gum tissue and periosteum located on the lingual side of the upper second and third molars. Examples of operations which can be performed following the posterior superior dental block injection are cavity preparation, removal of the pulp, shaping the crowns for bridge abutments, or any other operation which involves the teeth, the alveolar process, or the structures located buccally. If the upper second or third molar teeth are to be extracted, or any operation performed which involves the lingual tissue, then it is essential to block the anterior palatine nerve as it emerges from the posterior palatine foramen. (For technic of blocking the anterior palatine nerve, see page 501.) It is not necessary to infiltrate the gum tissue and mucous membrane to the buccal of the upper second and third molars, because the posterior superior dental injection blocks these structures. In some cases, small branches arising from the long buccal nerve, supply the buccal gum tissue and mucous membrane in this region in addition to the nerve supply derived from the posterior superior dental. The posterior superior dental injection blocks the long buccal nerve branches when present; therefore, only one deep injection is necessary.

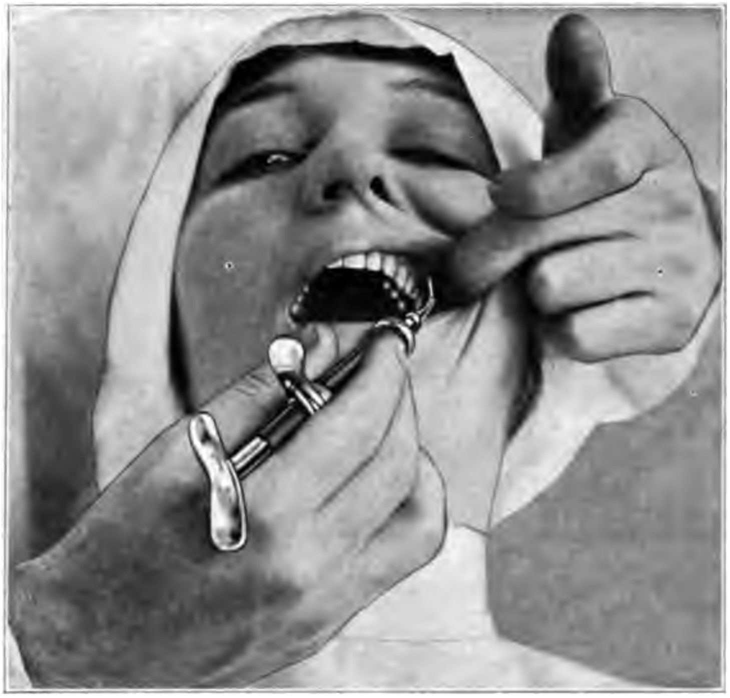


Fig. 269.—Starting the needle in the tissue for blocking the left posterior superior dental nerve.

Blocking the Interlacing or Overlapping Branches.—If the operation extends anterior to the upper second molar, it is essential to make a second injection for the blocking of the interlacing nerve branches. The posterior superior dental injection anesthetizes the region of the upper second and third molars, as described above. The upper first molar is the dividing line between the posterior and middle superior alveolar branches, and a profound anesthesia is secured by injecting at the posterior alveolar foramen, making it unnecessary to block the small communicating branches from the middle superior dental when the operation is to be confined to the region of the upper second and third molars.

Discussion of Various Methods of Anesthetizing the Middle Superior Dental Nerve.—It is impossible to block the middle superior dental by the deep block method (except by blocking the second division) inasmuch as this nerve is located beneath the lateral wall of the superior maxillary bone. (See Fig. 60.) Therefore, we must resort to other methods for blocking this particular nerve branch, and it is this nerve which has given many dentists trouble in anesthetizing the area which it supplies. This nerve branch is blocked by three different methods, which are as follows:

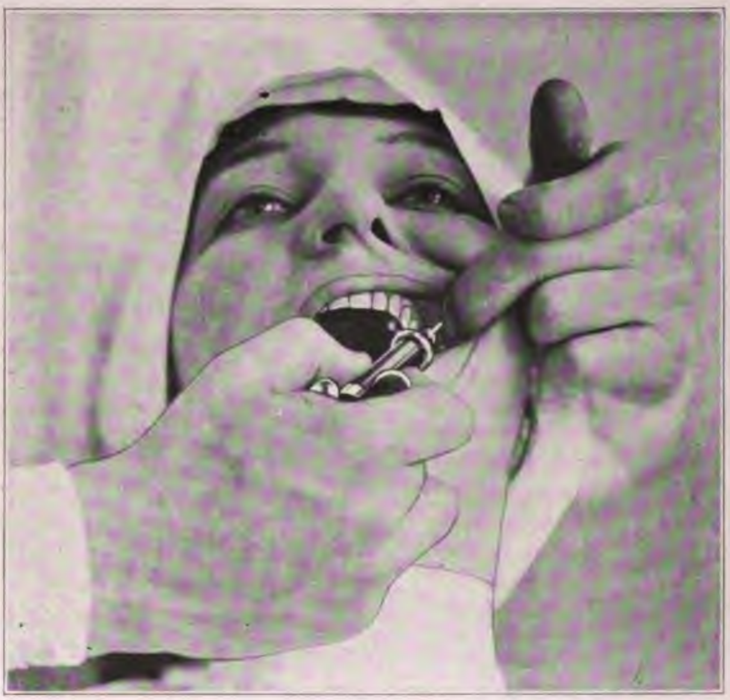


Fig. 270.—Injecting the solution for blocking the left posterior superior dental nerve.

1. Intraosseous method.
2. Subperiosteal infiltration, peripheral or terminal method.
3. Blocking the second division of the fifth nerve.

In many cases it is difficult to anesthetize the zone occupied by the two upper bicuspids and first molar by infiltration because the external alveolar plate may be so dense as to prevent the anesthetic solution from permeating and infiltrating through it. It is self-evident that if the density of the process is such as to prevent the solution from passing through it, there will be very little anesthesia obtained following an injection, even though it has been given in the best possible manner. Many times the author has been asked the question: "In what cases is infiltration or terminal anesthesia indicated in this particular region?" Such a question has been difficult to answer satisfactorily, inasmuch as it is difficult to ascertain whether the external alveolar plate is very dense or is porous. However, a general rule can be given which will apply to most cases.

Histology reveals that in the child or young adult, the external alveolar plate is porous, and with these individuals good results can be obtained from subperiosteal infiltration anesthesia; whereas, with patients past twenty-five or thirty years of age, the alveolar plate becomes hard and dense, and in such cases it is not always possible to secure profound anesthesia by the infiltration method. As the author has stated, this method gives excellent results in the child or young adult, and it can be used with a great deal of satisfaction, provided the injections are made properly.

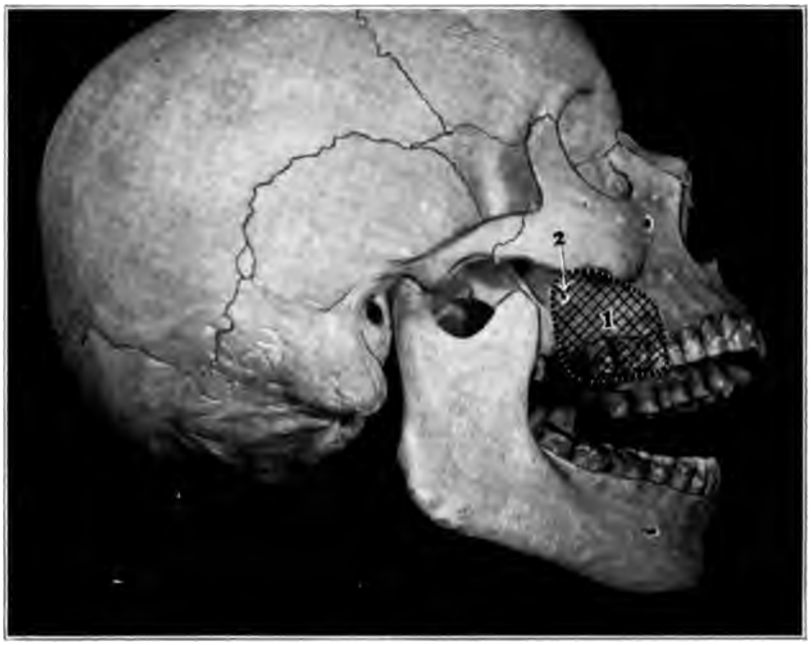


Fig. 271.—1. Outline which shows the area anesthetized by blocking the posterior superior dental nerve. 2. Posterior superior dental foramen.

During the author's lecture and clinical work before various societies, he has been given patients for operative work on the upper two bicuspids or first molar teeth, and in many instances his efforts have been a complete failure. In such cases the anesthetic solution was carefully injected over the external alveolar plate, and in some cases even second and third injections were made, and yet anesthesia was not secured so that the teeth could be removed or the sockets curetted without causing the patient pain. It is true that in many instances the infiltration or terminal method of anesthesia is a success if the roots of the teeth to be extracted are partially absorbed or if those teeth are not firmly attached. The writer has reference to the anesthetizing of teeth that are solid, and firmly attached to the alveolar process. Some operators have said that they can secure complete anesthesia of the teeth in this region by this method, even if they are in a sound condition. This has not been the experience of the author, as he has not in all cases been able to anesthetize this region by infiltration so that extensive operations could be painlessly performed. It is quite true that by this method complete anesthesia of the gum tissue and periosteum can be secured, and the painless application of the forceps can be made, but is not sufficient for the painless extraction of teeth, removal of granulomata or the painless removal of a pulp. Just because the soft tissues are completely anesthetized, and the painless application of forceps can be accomplished, it does not signify that the teeth can be removed without pain as the deeper parts are not completely anesthetized. The reader should remember that there is a vast difference between partial anesthesia and deep surgical anesthesia. The operator must not say that the infiltration or terminal method has been a complete success if only the application of forceps has been a painless procedure, but, when the teeth are removed, pain is experienced by the patient. By the infiltration method the pulp may be exposed without pain, and yet when the broach is inserted into the root canals, pain may be produced.

The many failures encountered by the author in anesthetizing this region caused him to formulate a technic for blocking the middle superior dental nerve with many patients of middle age and past, the intraosseous method is employed (see page 441) or the second division of the fifth nerve is blocked. (See page 380.)

BLOCKING THE MIDDLE SUPERIOR DENTAL (ALVEOLAR) NERVE BY THE SUBPERIOSTEAL INFILTRATION, PERIPHERAL OR TERMINAL METHOD

Topography of Anatomy.—The middle superior dental nerve is given off the infraorbital nerve about midway between the origin of the posterior and anterior superior dental branches. (See Figs. 40, 43, and 60.) In many cases it is given off in the floor of the orbit just after the infraorbital nerve enters the infraorbital canal. In some instances, it arises from the second division of the sphenomaxillary fossa just before the second division enters the posterior portion of the floor of the orbit. (See Figs. 51 and 68.) The direction of this nerve is downward and laterally, and is located beneath the mucous membrane and periosteum which lines the inner portion of the outer wall of the antrum. (See Fig. 60.) This nerve divides into small branches which assist in the formation of the superior dental or alveolar plexus, which is located above the first and second bicuspid and first molar teeth. (See Figs. 40 and 60.) Small branches enter the apices of the roots of the two upper bicuspids. In approximately 5 per cent of cases the upper first molar is supplied by the posterior superior dental, while in 95 per cent, it is supplied by both the posterior and superior dental branches.

In addition to the upper first and second bicuspids and first molar teeth, a portion of the superior maxillary bone, alveolar plate, buccal periosteum, gum tissue, and mucous membrane located between the gum tissue and teeth, are supplied by the middle superior dental. This nerve does not supply the structures located to the lingual of the upper bicuspids and first molar.

In making an infiltration or terminal injection buccally to the alveolar plate, the surface osteology must always be considered. In many cases, the external alveolar plate covering the roots of the bicuspids and first molar is uneven. The operator may experience difficulty in advancing the needle beneath the periosteum.

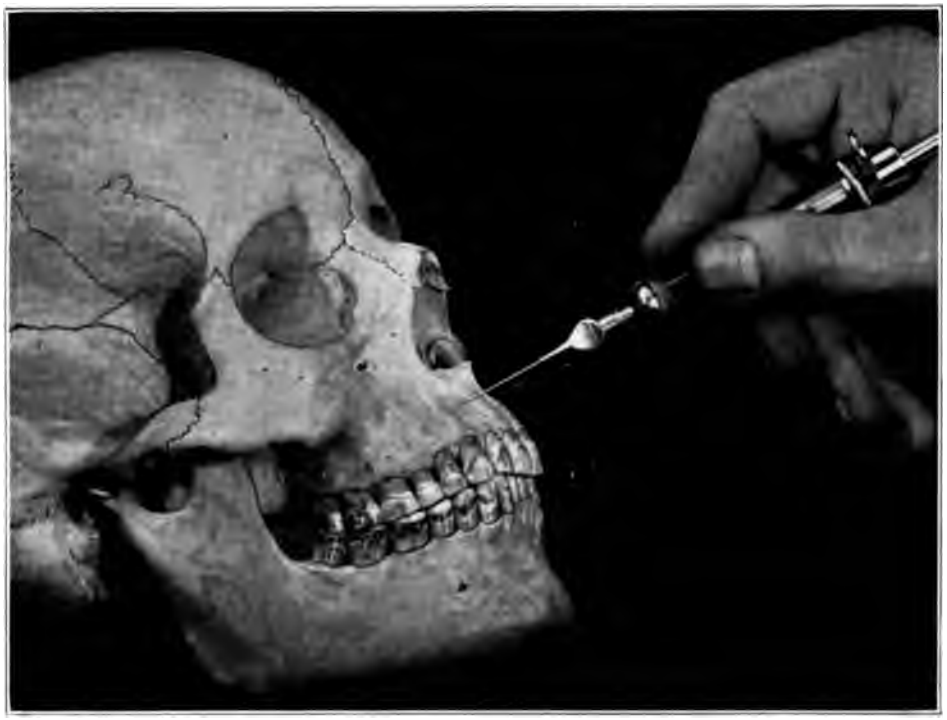


Fig. 272.—Illustrating the position of point of needle lateral to apex of upper cuspid for anesthetizing the upper first and second bicuspids and first molar by the subperiosteal method.

Needle Employed.—The needle used for blocking the middle superior dental by the infiltration, peripheral or terminal method is No. 3 or No. 4. Needle No. 3 is 15 mm. in length, 24 gauge, and is used in many cases where only one or two teeth are to be blocked. Needle No. 4 is 30 mm. in length, and 25 gauge, and is used where two or more teeth are to be anesthetized. (See Fig. 177.)

Technic of Injection.—The syringe is filled with two mils of the anesthetizing solution in case the upper two bicuspids and first molar teeth are to be operated. After the area has been prepared, the syringe is held in the hand pen fashion. The point of the needle is forced into the mucosa to the labial of the apex of the upper cuspid tooth, holding the barrel of the syringe and needle at an acute angle to the labial external alveolar plate on the same side of injection. (See Figs. 272, 273, and 274.) The needle is advanced into the mucosa, and five minims of the solution are slowly injected, (see Fig. 278) after which, several seconds should elapse before proceeding further with the needle. The syringe is now held parallel to the occlusal plane of the teeth (see Fig. 272) and the needle point is gently forced beneath the periosteum, where five minims are injected. (See Fig. 278.) The needle is advanced to the buccal of the apices of the bicuspids and first molar. Fig. 278 will show how the needle is advanced and how the solution is injected at various points. Each time the solution is discharged there should be, at least, fifteen seconds

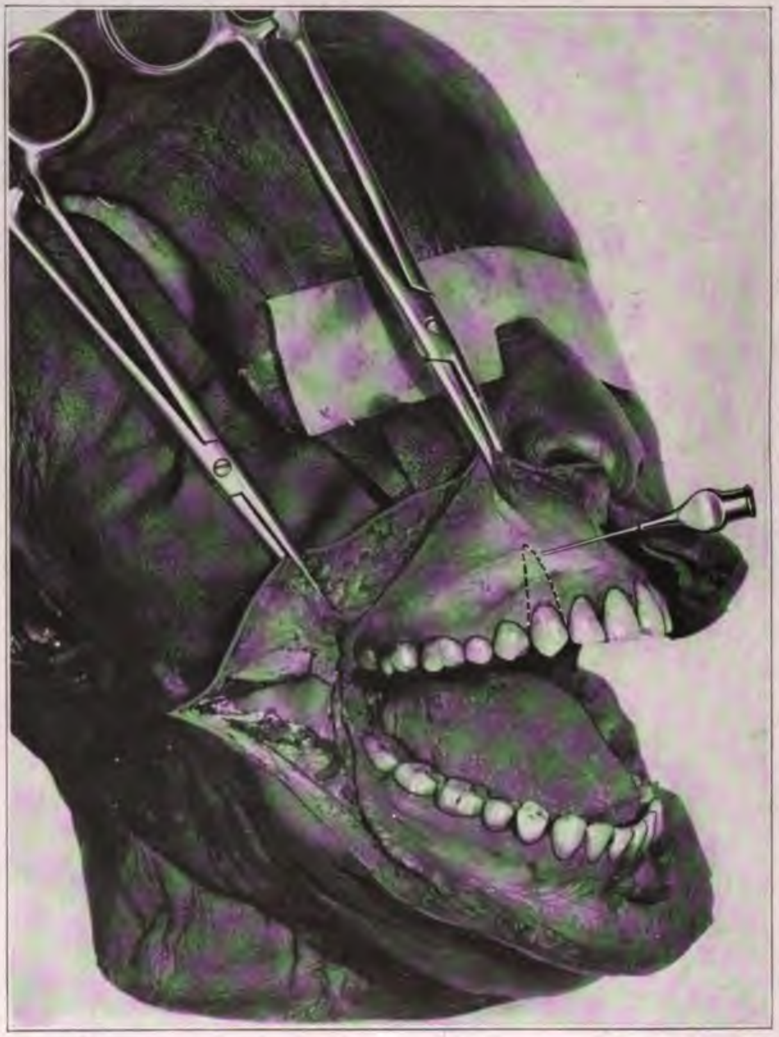


Fig. 273.—Wet specimen which illustrates the first position of needle for blocking the upper first and second bicuspids and first molar by the subperiosteal method. The initial puncture is made in region of apex of cuspid tooth.

elapse before advancing the needle farther into the tissue. Two mils of solution should be evenly distributed from the puncture point at the apex of the cuspid (see Figs. 273 and 274) and the finishing point, which is distal to the distobuccal root of the upper first molar (see Figs. 275, 276 and 278). The needle should be advanced posteriorly beneath the periosteum as much as possible, so that the solution will come in contact with the external alveolar plate. If the external alveolar plate is porous, the solution will permeate it readily and reach the branches of the middle superior dental nerve. If the solution is injected external to the periosteum, it will diffuse rapidly into the soft tissue, with a possibility that a sufficient amount of the solution will not permeate the external alveolar plate. The solution will follow the lines of least resistance, and if injected external to the periosteum, the least resistance is offered by the gum tissue and mucosa, which are far less dense than the periosteum and external alveolar plate (see Figs. 71 and 73). Therefore, the operator should be very careful to inject the solution beneath the periosteum, and great care should be taken not to injure the periosteum any more than is absolutely necessary. The periosteum is firmly attached to the alveolar process by Sharpey's fibers, and damage can be caused if the solution is injected too rapidly or if the needle is inserted promiscuously and with force, postoperative pain may result.

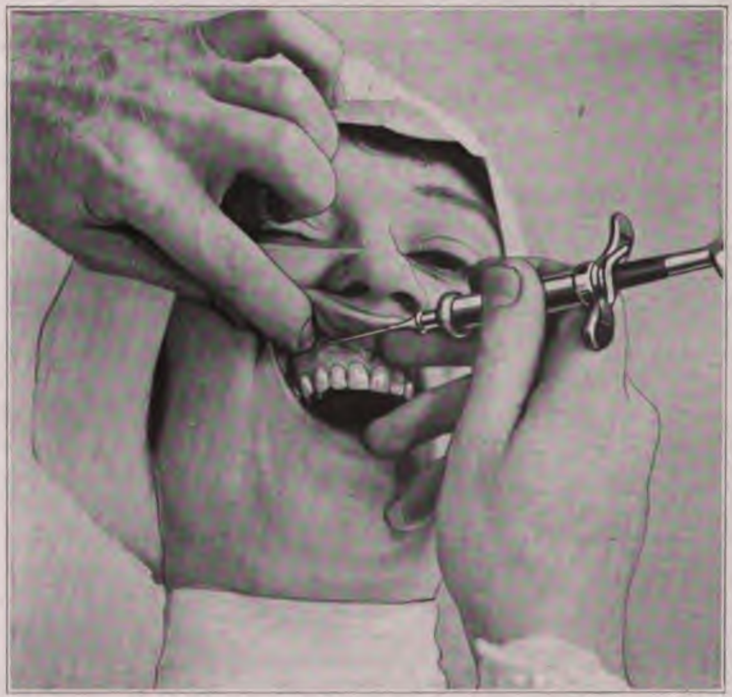


Fig. 274.—First position of syringe for blocking the upper first and second bicuspid and first molar by the subperiosteal method. The mucous membrane is punctured labial to the apex of the cuspid.

It will be observed from the above technic that the solution is injected anteriorly, buccally and distally to the operative area (see Fig. 278) and the reason for this is that there is a greater possibility for the solution to penetrate the external alveolar plate than if the solution is merely injected buccally to the teeth in question. This particular point has been emphasized considerably, and if the operator follows this technic, much better results will be secured than by injecting the solution buccally to the tooth or teeth to be operated.

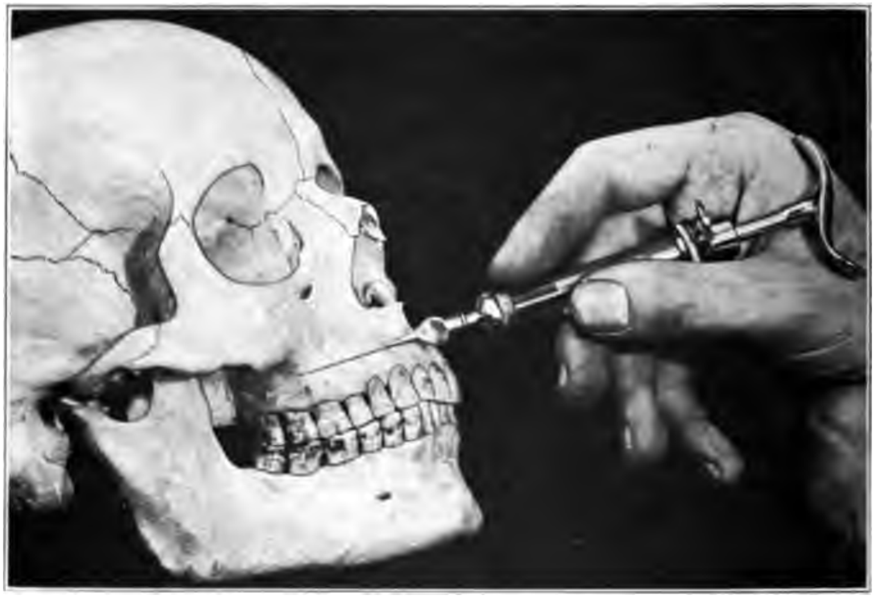


Fig. 275.- Position of needle for anesthetizing the upper first and second bicuspids and first mola by the subperiosteal method. Note that the syringe and needle are parallel to the occlusal plane of th teeth.

BLOCKING THE UPPER FIRST MOLAR BY THE SUBPERIOSTEAL, INFILTRATION OR TERMINAL METHOD

If the upper first molar is to be blocked by this method, the same techni is employed as previously outlined, with the exceptions given below. Th syringe is filled with two mils of the solution, and needle No. 4 is employed Instead of starting the needle to the labial of the apex of the cuspid tooth which is done for blocking the two bicuspids and first molar, the needle in thi particular instance is inserted into the mucous membrane buccally to th apex of the second bicuspid. The needle is extended backward beneath th periosteum, holding the needle parallel to the external alveolar plate and to th occlusal plane of the upper bicuspids and the first molar, until it reaches a poin distal to the mesio-buccal root of the upper second molar. Two mils of th solution are slowly injected at various points mesial, buccal, and distal to th first molar.

BLOCKING THE UPPER SECOND BICUSPID BY THE TERMINAL OR INFILTRATION METHOD

The same general principles are employed for the blocking of this tooth as described above. The needle is inserted buccal to the apex of the first bicuspid and forced backward parallel to the external alveolar plate and occlusal plane of the teeth. The solution is injected beneath the periosteum from the starting point until the needle reaches the region of the mesio-buccal root of the upper first molar. The amount of solution injected is one and a half mils and the needle employed is either No. 3 or No. 4.

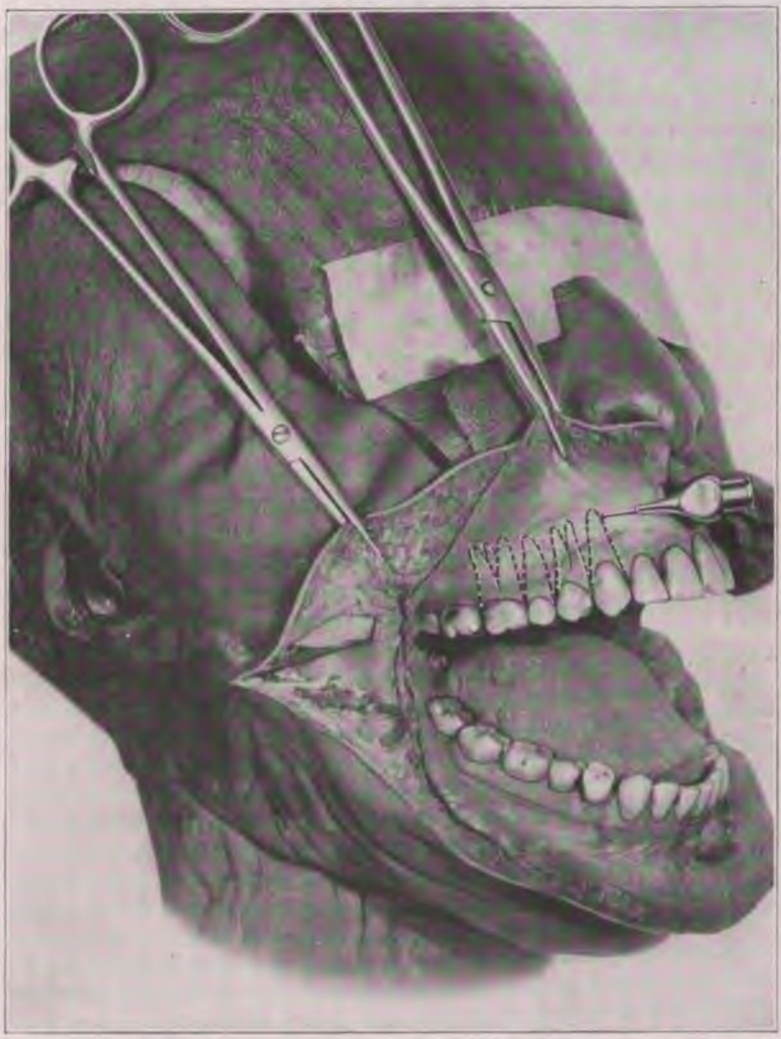


Fig. 276.—Position of needle for anesthetizing the upper first and second bicuspids and first molar by the subperiosteal method. The needle is advanced posteriorly beneath the periosteum until the needle point reaches an area distal to the upper first molar.

BLOCKING THE UPPER FIRST BICUSPID BY THE TERMINAL OR INFILTRATION METHOD

The same general principles as outlined above are applicable here. The needle is inserted to the labial of the apex of the cuspid tooth and is advanced parallel to the buccal alveolar plate beneath the periosteum until the point of the needle reaches the region over the apex of the upper second bicuspid. One and a half mils of solution are slowly injected. Needle No. 3 or No. 4 is employed. Too much emphasis can not be placed upon the fact that the solution should always be injected anteriorly, buccally, and posteriorly to the field of operation. (See Fig. 278.)

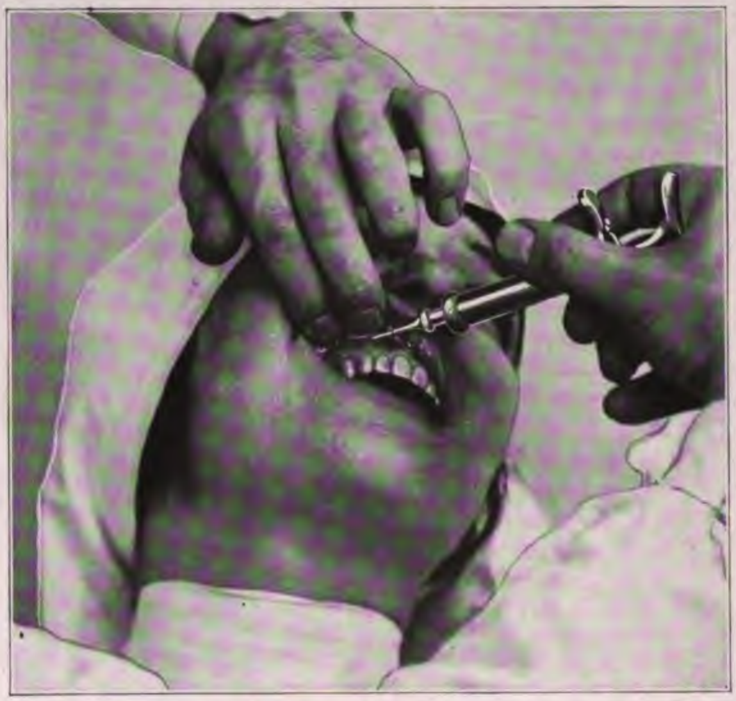


Fig. 277.—Showing final position of needle and syringe for anesthetizing the upper first and second bicuspids and first molar by the subperiosteal method. The point of needle is now located distal to the upper first molar. (See Figs. 275, 276, and 278.)

Injection of Solution by the Subperiosteal Infiltration Method.—In all cases the solution should be injected very slowly. It must be remembered that during an injection by this method the needle is situated beneath the periosteum, and that the periosteum is a very dense structure and is closely attached to the bone. It requires considerable steady pressure upon the plunger to discharge the solution beneath the periosteum. If too much pressure is exerted, the solution will be discharged too rapidly. This will cause a distention of the periosteum or a wheal which will cause soreness and postoperative pain. Therefore, a steady pressure upon the plunger so the solution will leave the syringe slowly, is highly advisable. Each time the solution is discharged, at least fifteen seconds should be allowed before advancing the needle farther beneath the periosteum. If this is not done, considerable pain will be inflicted upon the patient, and we must here again remember that we should never sacrifice thoroughness for speed. In case the two upper bicuspids and first molar teeth are to be anesthetized by this method, at least two mils of the solution should be injected. If one tooth is to be blocked, then one and a half mils should be used. If the needle is not located beneath the periosteum, the solution will be injected into the mucosa, which requires very little pressure to discharge it. When such a condition is met, the needle should be withdrawn and the point gradually forced beneath the periosteum so that the solution will be deposited in contact with the external alveolar plate.

Precautions.—Always observe that the needle is being advanced posteriorly parallel to the external alveolar plate and to the occlusal plane of the upper teeth in the region that is being injected. The needle must be in contact with the external alveolar plate beneath the periosteum. Inject slowly and avoid unnecessary trauma and distention of the periosteum and mucosa which will cause postoperative complications. Never employ a needle of large diameter, because such a needle will cause unnecessary trauma of the parts. After injecting at each point wait at least fifteen seconds before advancing the needle. Always inject anteriorly, buccally and posteriorly to the operative area. Remember that if the plate of bone is not porous, complete anesthesia will not be secured, and in such cases the intraosseous method or the blocking of the second division, should be employed.

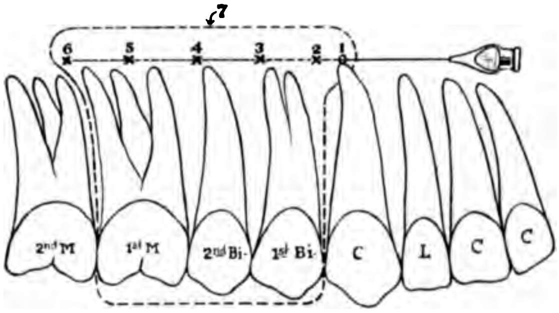


Fig. 278.—The outline of the passage of needle as it is advanced beneath the periosteum for blocking the upper first and second bicuspids and first molar teeth by the subperiosteal method.

1, initial starting point of needle where 5 minims of solution are injected; 2, 3, 4, 5, and 6 indicate various points of injection. Each location indicated by X represents points at which 5 minims of solution are injected; 7, illustrates the area anesthetized.

Time to Wait for Anesthesia.—When the solution has been properly injected, and in the proper quantity, anesthesia should be secured in three to five minutes. In case the external plate of the alveolar process is extremely porous, anesthesia will be secured in two minutes; whereas, on the other hand, if considerable density exists, from five to eight minutes time should elapse before sufficient anesthesia has been obtained. If a sufficient depth of anesthesia has not been obtained following the first injection, there is no harm in repeating the technic and injecting the same quantity of solution as previously injected.

Structures Anesthetized.—The structures which are blocked depend, of course, upon the starting and finishing point of the needle (see Fig. 278). In case the solution is distributed over the buccal surface of the upper first and second bicuspids and first molar teeth, extending from the apex of the cuspid to a point distal to the upper first molar, anesthesia of the above-named teeth should be obtained, and in addition, the alveolar process, buccal periosteum, gum tissue and mucosa. This injection will not anesthetize the gum tissue and periosteum on the lingual side. Therefore, a lingual blocking must be given. The buccal injections, as given above, are sufficient for cavity preparation, pulp removal, or the shaping of the crowns of the teeth for bridge abutments, or any other operation which does not involve the lingual structures. In case the teeth are to be extracted, or in case of curettement in the treatment of pyorrhea alveolaris, or in any case in which the lingual structures are implicated, a lingual injection must be made. Anesthesia on the lingual side is produced by blocking the anterior palatine nerve, not at the posterior palatine foramen, but to the lingual of the apex of the lingual root of the upper first molar, at which place the anterior palatine nerve is located. (For detailed technic for blocking anterior palatine nerve, see page 501.)

The same general principles are applicable to the structures anesthetized, and to the lingual blocking, as given above, when the first bicuspid or second bicuspid or both bicuspids or the first molar are individually blocked.

Blocking the Interlacing or Overlapping Branches.—When the subperiosteal, terminal, peripheral, or infiltration method is employed, it is not necessary to make an injection for blocking the interlacing or overlapping branches, inasmuch as the solution injected blocks all branches in the immediate region of operation, provided the solution penetrates the alveolar plate.

BLOCKING THE MIDDLE SUPERIOR DENTAL (ALVEOLAR) NERVE BY THE INTRAOSSEOUS METHOD

Topography of Anatomy.—The anatomy of the middle superior dental nerve has been given in Chapter VII, also under the subperiosteal, infiltration or terminal method of anesthesia. The reader should familiarize himself with the nerve distribution before studying the technic.

The middle superior dental nerve can not be reached directly with the needle; therefore, it is necessary to anesthetize the structures supplied by it. by other methods. This nerve is located beneath the outer surface of the superior maxillary bone and supplies the middle zone which is occupied by the two upper bicuspids and first molar teeth. In addition to these teeth, it supplies the alveolar process, the outer wall of the antrum, buccal periosteum, gum tissue and mucosa. It assists in the formation of the superior dental plexus which is located above the roots of the three above-named teeth. This plexus is formed by the uniting of the posterior, middle and anterior dental branches. (See Figs. 40 and 60.)

The external alveolar plate which covers the roots of the above three named teeth varies in thickness, the average being about three millimeters, and it may be porous or dense in structure. (See Figs. 71, 72, 73, and 284.) In the child and young adult it is very porous, whereas in people past thirty years of age, in most cases, it is very dense, which prevents the solution from readily passing through the process to produce anesthesia of the teeth. The buccal surface of the external alveolar plate is, in most cases, irregular in outline, and in some instances the roots of the teeth are located near the buccal surface, producing prominences, which can, in most cases, be palpated with the index finger. In case the roots are deep-seated, the buccal plate is usually smooth.

History of Intraosseous Method of Anesthesia.—The credit for first injecting the anesthetic solution into the middle or cancellous plate of bone belongs to Otte, who demonstrated it in 1896, and soon thereafter he presented his findings to the profession. Parrott, experimenting independently of Otte, published his work on the subject. Otte also published his findings in 1896, and recommended that the solution be injected directly into the middle plate of bone. At the time he presented his technic, local anesthesia was not used to any extent, and it is for this reason the work of Otte was almost forgotten. Since the advent of this method of anesthesia there have been a number of modifications presented by Masselink, Hein and the author.

The technic described by Otte is as follows: The gum tissue is first thoroughly cleansed with an antiseptic solution. Following this a small amount of the anesthetizing solution is injected at the gingival margin of the tooth by inserting the needle several times. After four or five minutes time an opening is made through the gum tissue and external alveolar plate on the buccal side with a bur or a Gates-Glidden drill. Otte recommends that the opening be made more or less at a right angle with the long axis of the tooth and a short distance below the position of the apical foramen in single-rooted teeth and between the roots in molars. The hypodermic needle should be of the same diameter as the drill. Before the opening is made with the drill, the mucosa is placed under tension as much as possible to avoid laceration from the revolving instrument. The drill is now forced through the external alveolar plate until it drops into the middle cancellous plate of bone. The next step is to insert the hypodermic needle into the opening which has been made with the drill, and the solution is then slowly injected into the cancellous bone.

The Author's Method of Producing Intraosseous Anesthesia.—The author has endeavored to simplify the intraosseous method by evolving a new technic for blocking the area supplied by the middle superior dental nerve. The pioneer work of Otte, Parrott and Masselink was a stepping stone towards advancement and it laid the foundation for more efficient methods. Intraosseous anesthesia is of great value to the oral surgeon and dental practitioner, and it is of immense importance in the execution of our work. With all due respect to the pioneers who have blazed the way, it is the opinion of the author that their methods did not fulfil the requirements in an ideal way for the production of anesthesia by the intraosseous method.

Failures Encountered in the Zone Occupied by the Upper Bicuspids and First Molar Teeth.—It has not only been the experience of the author to fail many times in blocking this zone, but it has also been the experience of hundreds of operators who have attempted to anesthetize this particular zone by the subperiosteal, terminal or infiltration method. This particular phase has already been discussed under the head of "Blocking the Middle Superior Dental Nerve by the Subperiosteal, Terminal or Infiltration Method," on page 430, but the author considers it to be of so much importance that a short discussion will be given here.

In individuals of middle life or past, the external alveolar plate, which covers the three above-named teeth, is so dense that it may not allow the solution to really permeate it to produce profound anesthesia of the parts, and even after the operator has carefully injected the solution over the buccal area, which has already been described, many times his earnest effort will result in disappointment and failure. This very thing has happened to the author many times while giving clinics before societies, and the disappointment and embarrassment induced the author to search for other methods of blocking the middle superior dental nerve which has been the "joker or bugbear" to the operator in the great system of block anesthesia, inasmuch as the nerve branch which supplies this area is completely enclosed within bone, and it is impossible to reach it with the needle to anesthetize it by the deep block method. Other methods, therefore, must be resorted to in many cases in order to produce deep anesthesia of the parts so that an operation can be performed upon the teeth or the tissues of this part.

After searching the field most diligently and carefully for an efficient method of blocking this area, especially in those cases which will not yield to the subperiosteal infiltration or terminal method, the author put forth every effort to evolve some method whereby this particular part could be thoroughly blocked with accuracy, and to work out a technic which can be easily mastered. The two methods that are recommended are (1) Intraosseous method; (2) Blocking the second division of the fifth nerve by the intraoral method.

The intraosseous method is highly efficient when no infection is present, such as inflammation, swelling, or alveolar abscess. The second division block is indicated when infection of this part is present. The second division block is contraindicated for the blocking of this zone unless infection is present. When the second division is blocked, the amount of anesthesia produced is extensive. The writer has termed the intraosseous method of anesthesia the "missing link," and it is no doubt a very fitting term, inasmuch as it does fill in the missing link which has been encountered in block anesthesia.

The difficulties which have been encountered by the infiltration or terminal method of anesthesia for blocking this area have been explained and it is not the object to condemn the infiltration or terminal method but it is the intention to point out the indications and contraindications for this form of anesthesia. The writer does not believe in adhering to any set rules while applying any anesthetic, either general or local, but he does believe in the operator using any method which seems to be best adapted to the individual case, and if this broad view is taken, better results will be secured than to employ a certain method in all cases. The subperiosteal, infiltration or terminal method of producing anesthesia is of great value in selected cases. In nearly every case success is attained, if it is employed upon young individuals, say under twenty-five years of age, or upon other individuals who have portions of roots of teeth remaining which are not firmly attached, or in any other case in which it is unnecessary for the solution to enter the external alveolar plate and produce profound anesthesia of the deep alveolar process. In this instance we might mention the treatment of pyorrhea alveolaris. In those individuals where good results are obtained from using infiltration anesthesia, the external alveolar plate is porous and readily allows the solution to pass through it into the middle plate of the alveolar process. However, it is known from experience and from the study of histology of bone that the older the patient the more dense the bone.

It is very disappointing to the operator to inject the solution by the terminal or infiltration method, and wait a sufficient length of time for anesthesia, and when the operation is started, find that anesthesia is not complete, and if the operation is continued, considerable pain may be experienced by the patient.

When the intraosseous method is employed, the region of the upper bicuspids and first molar can be blocked with more satisfaction to both the patient and the operator than is usually accomplished through the medium of infiltration anesthesia. Numerous cadavers have been dissected and many skulls have been examined; the histology of bone structure and the nerve supply of these parts have been studied in order to arrive at some definite basis before presenting the technic to the dental profession.

AUTHOR'S METHOD OF BLOCKING THE TWO SUPERIOR BICUSPIDS AND FIRST MOLAR, ALVEOLAR PROCESS AND BUCCAL STRUCTURES WHICH ARE SUPPLIED BY THE MIDDLE SUPERIOR DENTAL NERVE BY THE INTRAOSSEOUS METHOD

Instruments Employed in Intraosseous Block Anesthesia.—In carrying out the technic which has been evolved several intraosseous instruments are required which are as follows:

1. *Double-bladed Intraosseous Lancet and Retractor.*—This instrument (see Fig. 205) is used to pierce the mucous membrane and periosteum covering the external alveolar plate, slightly above and between the apices of the roots of the teeth at the point of injection. It is held in the hand as one would hold a knife, while it is being inserted through the tissues and in contact with the alveolar process. (See Figs. 281 and 290.) The two cutting blades are beveled on one side only, and the cutting edge of each blade is about one and one-half millimeters in length. These two blades are squeezed together with the thumb and index finger.

2. *Intraosseous Guide or Template.*—The intraosseous guide or template (see Fig. 206) is to guide the drill through the external alveolar plate. This instrument is placed between the blades of the double-bladed intraosseous lancet and retractor prior to the time of inserting the drill. (See Fig. 291.) The guide is 7 millimeters in length, its end being sharp so as to retain its position when lateral pressure is applied to it against the external alveolar plate. The end which rests against the external alveolar plate is on a line drawn through the long axis of the instrument so as to eliminate its rotating while in use.

3. *The Intraosseous Drill.*—The intraosseous drill (see Fig. 207) is bi-bevel, cuts only on the end, is self-cleansing, and is 1/2,400 inch less in diameter than the 21 gauge needle which is employed in the injecting of the solution. The drill is 13 mm. in length and the guide 7 mm. in length; therefore, the drill extends through the guide a distance of 6 mm., which is sufficient to pass through the external alveolar plate, with rare exceptions.

4. *Intraosseous Needles.*—Two needles are employed in making an intraosseous injection. Needle No. 7 (see Fig. 177) is used for the preliminary injection. This needle is 10 mm. in length, 27 gauge, very fine and sharp, and can be inserted in the region where the intraosseous injection is to be made in order to anesthetize the mucosa and periosteum prior to applying the retractor and drill.

The second needle employed is No. 1, which is 10 mm. in length and 21 gauge. This needle is cone shaped on the end and, when passed through the guide or template, extends beyond the guide tip a distance of 3 mm., which enters the external alveolar plate, giving perfect contact between needle and bone. The drill, as previously described, is 1/2,400 inch less in diameter than the intraosseous needle. The guide or template directs the needle into the small opening which has been made by the drill of slightly less diameter, thereby giving perfect contact between the needle and bone, which prevents the loss of solution during the process of injection.

Technic of Injection for Blocking the Zone Occupied by the Upper First and Second Bicuspids and First Molar Teeth.—The technic given here applies to the blocking of the upper first and second bicuspids and first molar teeth, alveolar process, buccal periosteum, buccal gum tissue, and mucosa.

The first step in the technic is to thoroughly prepare the area to be blocked, as given on page 355. After this region has been carefully prepared, a preliminary injection is made by using needle No. 7 which is very fine, and sharp. (See Figs. 279 and 280.) All intraosseous injections should be made slightly above and distally or mesially to the apex of the tooth or apices of the teeth to be operated. For blocking the zone occupied by the three above-named teeth the intraosseous injection is made above and distally to the apex of the upper second bicuspid tooth. The small preliminary needle is now mounted upon the syringe which is filled with two mils of the injecting solution. Insert the point of the needle into the mucosa above and distally to the apex of the root of the upper second bicuspid tooth. (See Fig. 280.) After the needle has been advanced beneath the surface of the mucous membrane, inject three minims, and then wait at least one-half minute to allow the solution to produce a surface anesthesia. Now gradually force the fine needle downward until it strikes the periosteum, but before inserting the needle beneath it, inject three minims of the solution. After again waiting for one-half minute, gradually force the needle beneath the periosteum and inject three more minims. The amount of solution injected by this preliminary injection to produce surface anesthesia is, in most cases, one-half mil. This will leave one and a half mils in the syringe, which is injected into the middle plate of process to block the three above-named teeth.

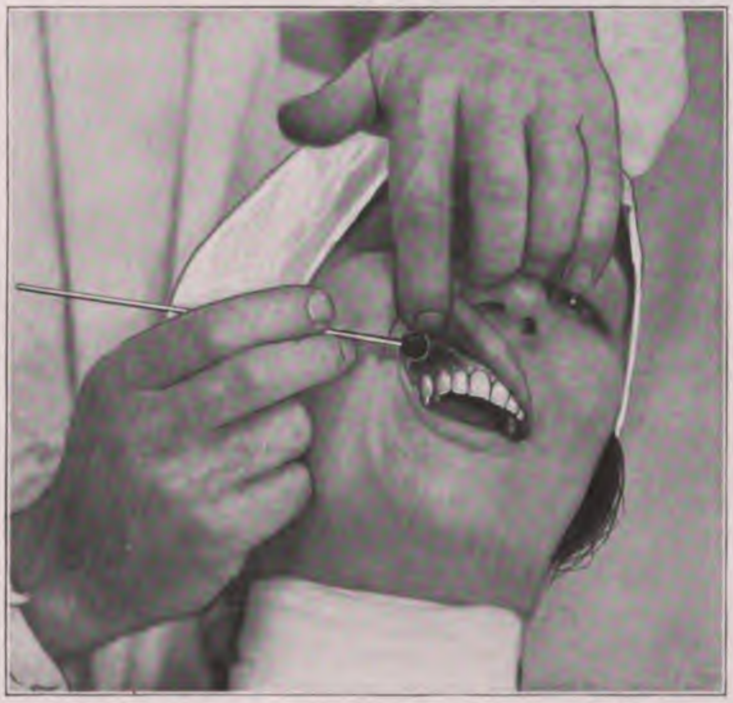


Fig. 279.—Applying germicidal solution to mucous membrane in region of cuspid and first bicuspid teeth.

Object of Making the Preliminary Injection.—1. To produce a surface anesthesia of the mucosa and periosteum which covers the external alveolar plate at the point where the drill is to be inserted. Unless the injection is made, pain will be caused while the drill is being passed through the periosteum and external alveolar plate, and there is great liability of the patient moving at the time this is being done, which may result in breaking the drill. Following the preliminary injection no pain whatsoever is produced while proceeding with the technic. *These injections can be made upon the most*

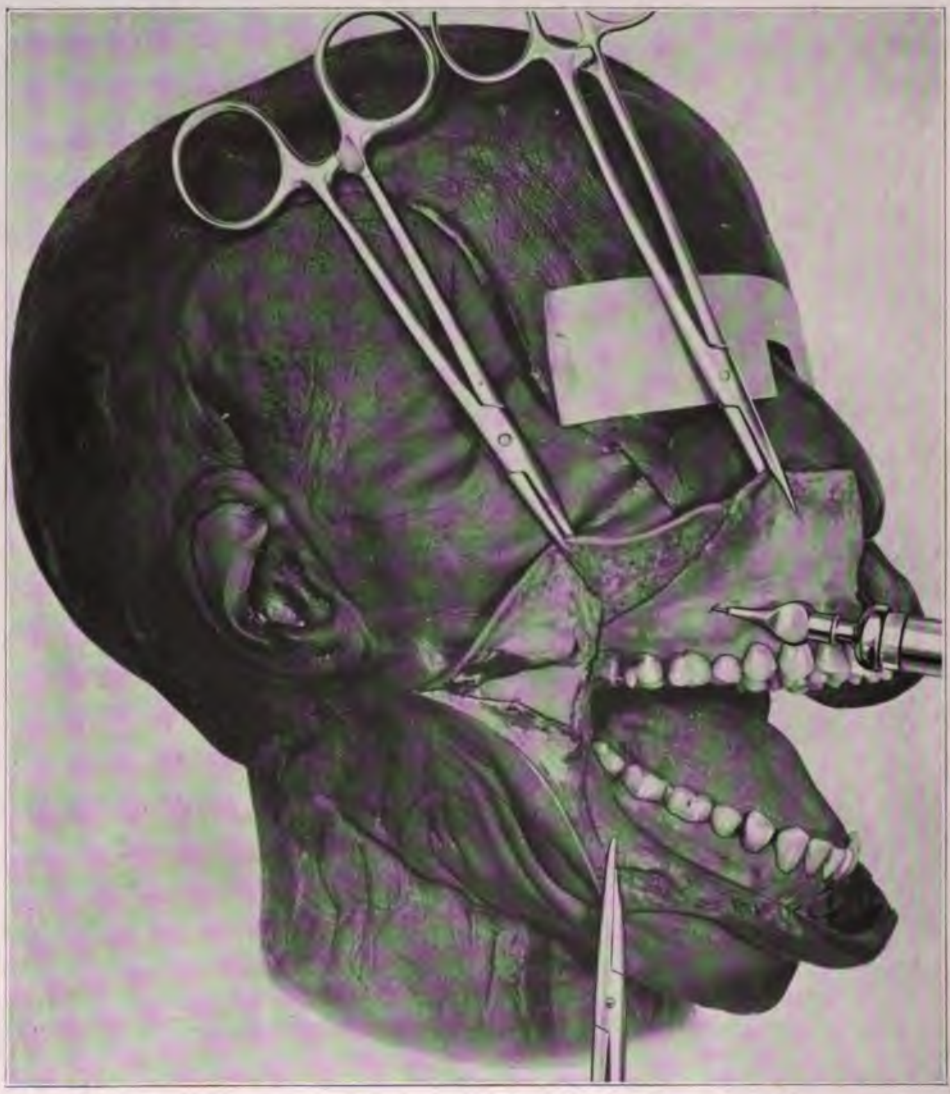


Fig. 280.—Showing the region of preliminary injection which precedes the blocking of the upper first and second bicuspid, and first molar teeth by the intraosseous method.

sensitive patient without causing any complaint or producing any pain whatsoever.

2. Another important reason for making a preliminary injection is to produce local anemia of the tissue which is produced through the vasoconstricting action of the adrenalin. This local ischemia materially lessens or wholly prevents hemorrhage after using the small double-bladed intraosseous lancet and retractor.

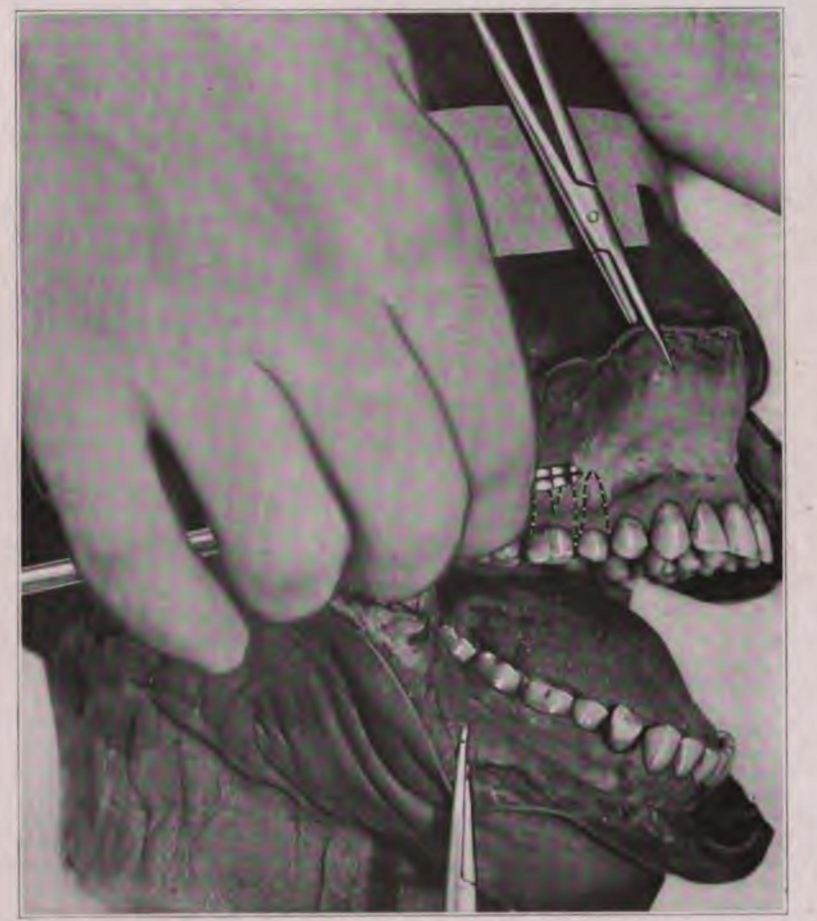


Fig. 281.—Inserting the double-bladed lancet and retractor buccally and between the apices of the second bicuspid and mesiobuccal root of the upper first molar. This is the location for the blocking of the branches of the middle superior dental nerve.

The double-bladed intraosseous lancet and retractor is now held in the hand like one would hold a pocket knife and the two blades are squeezed together. (See Fig. 281.) The patient's mouth should be partially open in order to allow the cheek to be distended as far laterally as possible. (See Fig. 290.) With the blades of the lancet and retractor in contact with each other, they are now forced through the anesthetized mucosa and periosteum until they reach the outer portion of the external alveolar plate, the operator being very careful that the ends of the cutting blades are resting flatly upon the external plate of bone. Now work the instrument back and forth through a distance not to exceed one millimeter, which will cause the blades to pierce the periosteum. Take the template or guide (see Fig. 291) in the left hand and place the cone-shaped point between the two blades of the intraosseous lancet and retractor, gradually forcing the guide between the blades to separate them. The blades of the intraosseous lancet and retractor will spring apart slightly after the tension has been relieved by taking away the index finger and thumb. The template or guide should be extended downward between the blades until it reaches the external alveolar plate. The lancet should now be removed from the part as it has accomplished its purpose. The template or guide should be held in the left hand. Some pressure should be exerted on the external alveolar plate by the guide so the

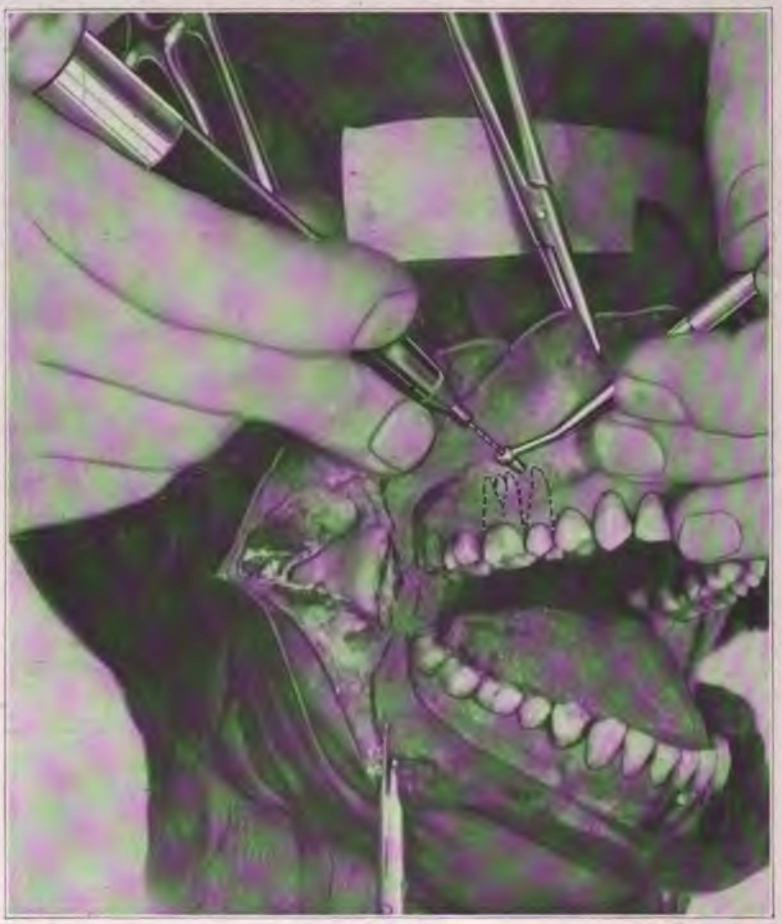


Fig. 282.—Inserting the drill through the guide.

sharp end can embed itself slightly into the alveolar process and its position be retained. If the guide moves laterally only a fraction after the opening has been made by the drill, it will be impossible to locate the opening with the needle.

The sharp end of the template or guide is now resting against the external alveolar plate, and no trauma or laceration of the mucous membrane or the gum tissue has been produced. After the operator has succeeded thus far with the technic, he should take plenty of time in observing that the long axis of the template or guide is at right angles to the surface of the external alveolar plate. If it is not held at right angles while the drill is being inserted, but assumes more or less of an acute angle with the bone, there is some danger

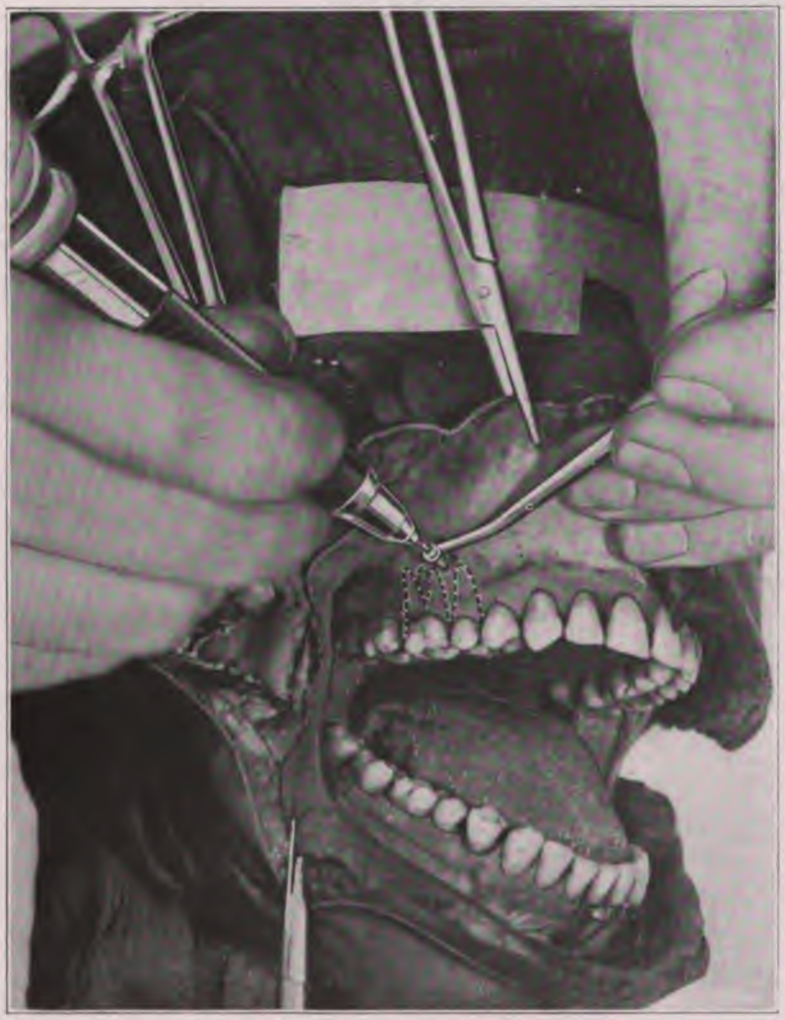


Fig. 283.—Inserting the drill through the guide and external alveolar plate into the cancellous process.

of passing the drill into the peridental membrane or into the end of the root of the second bicuspid or the mesio-buccal root of the upper first molar. The object of making the intraosseous injection so high is to eliminate the possibility of forcing the drill into the root of the tooth or the peridental membrane, which can be eliminated if the operator uses due care and judgment.

The drill is now passed through the guide and in contact with the external alveolar plate. (See Fig. 282.) Great care should be taken not to use excessive pressure upon the drill, attempting to force it through the external alveolar plate too quickly. It is advisable to allow the drill to cut slightly, and then retract it, and place it in contact with the plate of bone again, and repeat this procedure until the external plate has been pierced. It must be

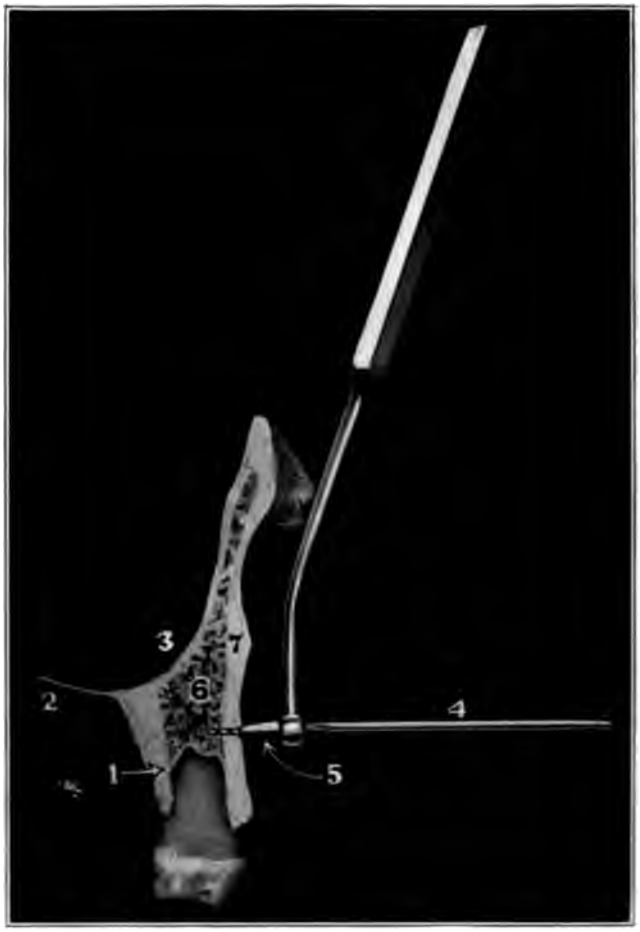


Fig. 284. Cross section of superior maxillary bone situated between upper bicuspids illustrating the guide and intraosseous drill in position. Note that the drill has entered the middle cancellous process.

1, lingual plate of bone; 2, portion of hard palate; 3, lateral wall of antrum; 4, intraosseous drill in position; 5, template portion of intraosseous guide in position; 6, inner cancellous portion of bone; 7, buccal plate of bone.

remembered that the drill is very small, and that if excessive pressure is used upon it, there is a possibility of its breaking. The object is to use as small a drill and needle as possible in order that a small opening can be made. While extending the drill through the guide and external alveolar plate, lateral pressure should not be exerted upon the handpiece. The operator can easily detect when the drill enters the middle porous portion of the alveolar process, because there is a vast difference in the amount of resistance required in extending the drill through the external alveolar plate as compared with the middle cancellous plate. The sensation experienced by the operator when the drill enters the middle cancellous bone is very similar to that when a bur enters the pulp chamber of a tooth. (See Fig. 284.) When the drill enters the middle porous portion it is not advanced

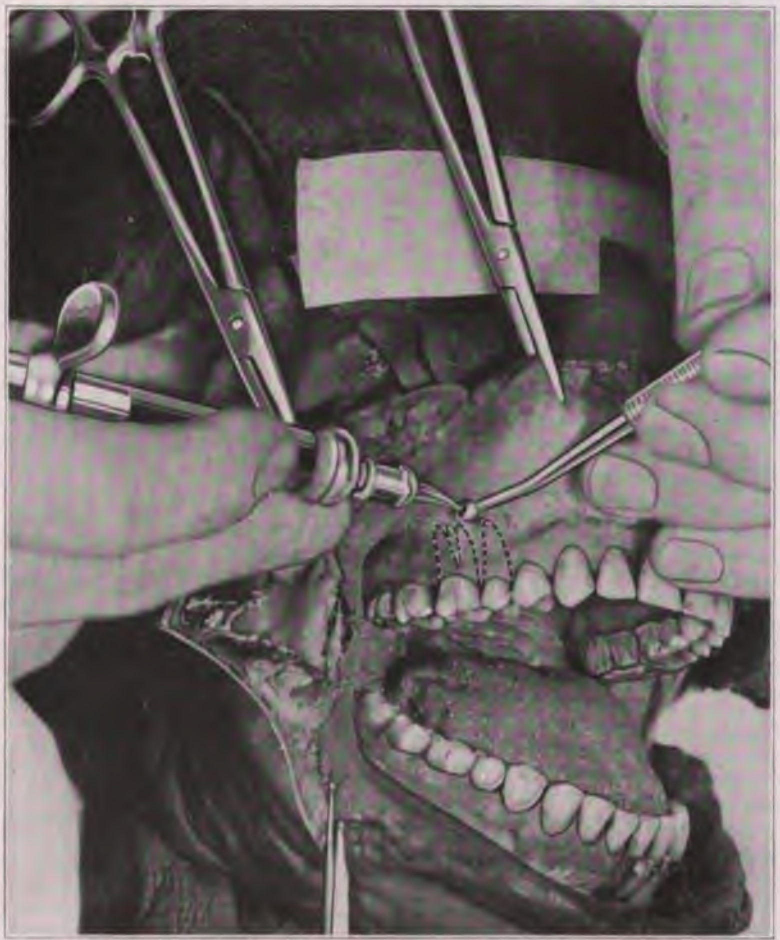


Fig. 285.—Inserting the needle through the guide, into the opening made by the drill so perfect contact will be obtained between needle and process.

any further. After the drill has been removed, extreme caution should be observed so as not to cause the slightest movement of the template or guide, because a slight movement from its original position will make it extremely difficult or impossible to locate the opening with the needle. In some few cases, when the drill is being extended through the external alveolar plate, it does not enter a porous middle plate of bone but instead, a density exists, and an equal amount of pressure is required while extending the drill through both the external and internal plates of bone.

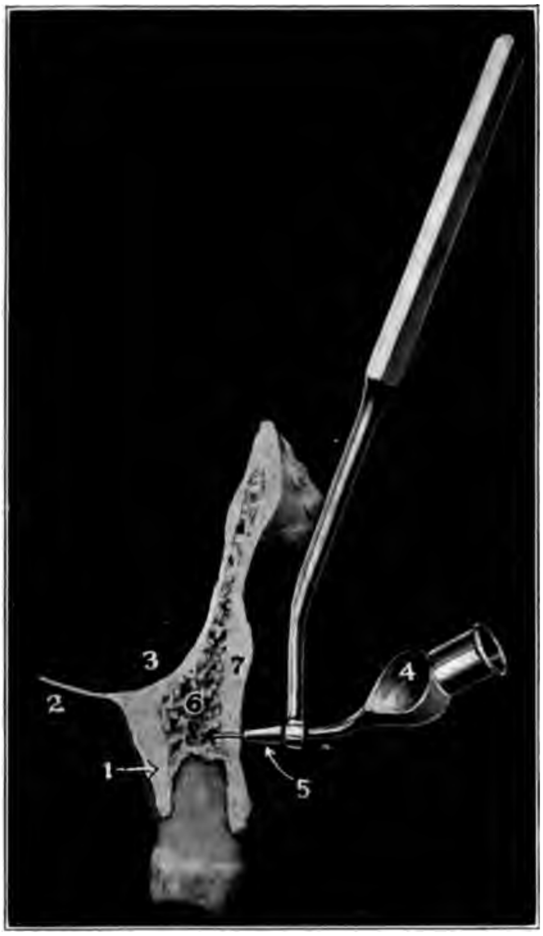


Fig. 286.—Illustrating the guide and needle and their relationship to the external alveolar plate. Note that the sharp end of guide is in contact with the external alveolar plate.

1, lingual plate of bone; 2, portion of hard palate and floor of antrum; 3, lateral wall of antrum; 4, intraosseous needle in position; 5, template portion of intraosseous guide in position; 6, inner cancellous portion of bone; 7, buccal plate of bone.

The author has encountered five cases in which no cancellous middle plate was reached by the drill, and the conclusion was that no cancellous middle plate existed in these patients, but instead an extreme density. In these cases the drill was removed and inserted in several different directions, but it was impossible to penetrate the external alveolar plate and reach the inner porous portion in any case. An attempt was made to inject the solution, but it was difficult to force it into the jaw, inasmuch as the bone was so dense it would not take up the solution, making it difficult to produce anesthesia by this method.

In patients of this type good results can not be secured by the intraosseous method, and if anesthesia can not be produced by this method, it would be unreasonable to expect that the part could be anesthetized by the subperiosteal, terminal or infiltration method. In these five cases the author succeeded in producing anesthesia by blocking the second division of the fifth nerve by the intraoral method. Such cases as described are uncommon. The external alveolar plate varies in thickness, and in some cases the roots of the teeth are located very close to the surface of bone, while in other instances,

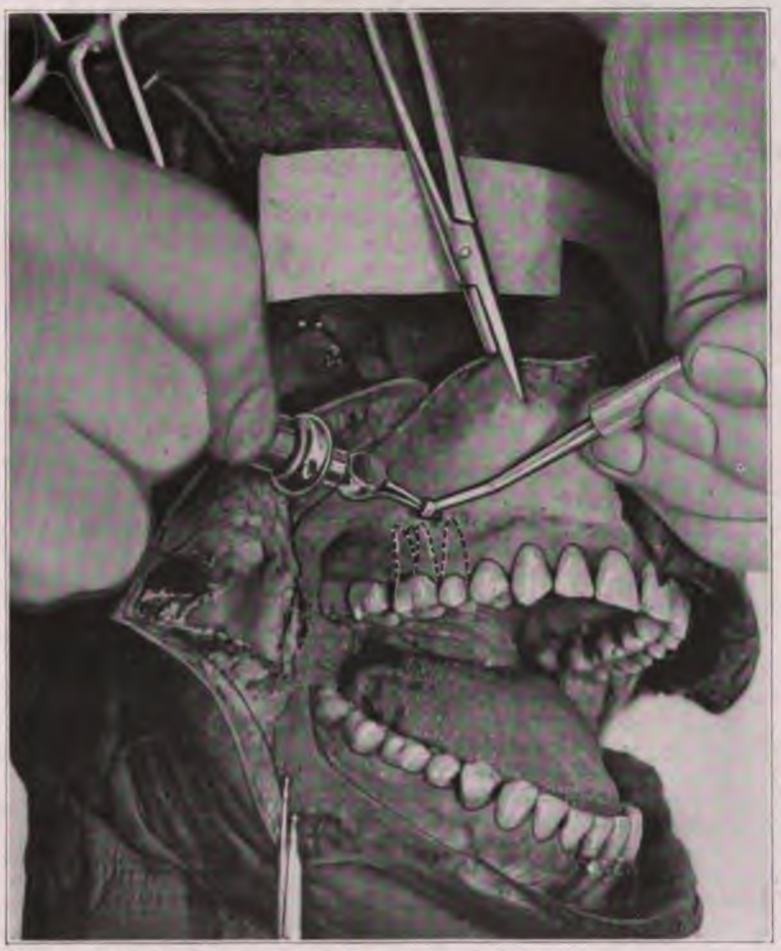


Fig. 287.—Injecting the solution through the guide and external plate into the cancellous process for blocking the branches of the middle superior dental nerve.

the roots are deeply embedded with considerable bone covering them. Figs. 71, 72, 73 and 284 will give the reader an idea as to the variations in the thickness of the external alveolar plate.

The next step in the technic is to inject the solution into the middle plate of bone. The needle, which is 10 mm. in length, and 21 gauge, is now mounted upon the syringe which contains 1½ mils of the injecting solution. The syringe is held in the right hand, and the guide or template is held in the left hand. (See Fig. 285.) The needle, which is cone-shaped on the end, is now passed through the guide until the external part of the opening in the external alveolar plate is reached. As previously remarked, the needle is 1/2,400 inch greater in diameter than the drill, therefore a rotating movement of the syringe and needle is advised in order that the needle may enter the opening in the external plate. The reason for using a needle a fraction larger than the opening is that it will give perfect contact between needle and bone, which will obviate any leakage of the solution, and the operator will know exactly how much solution he is injecting. As the guide is 7 mm. in length, and the intraosseous needle 10 mm. in length, the needle will pass through the guide a distance of 3 mm., which amount is contained in the opening made by the drill. (See Fig. 286.) The needle is straight, but is mounted upon a hub which is slightly curved, making it more convenient for the

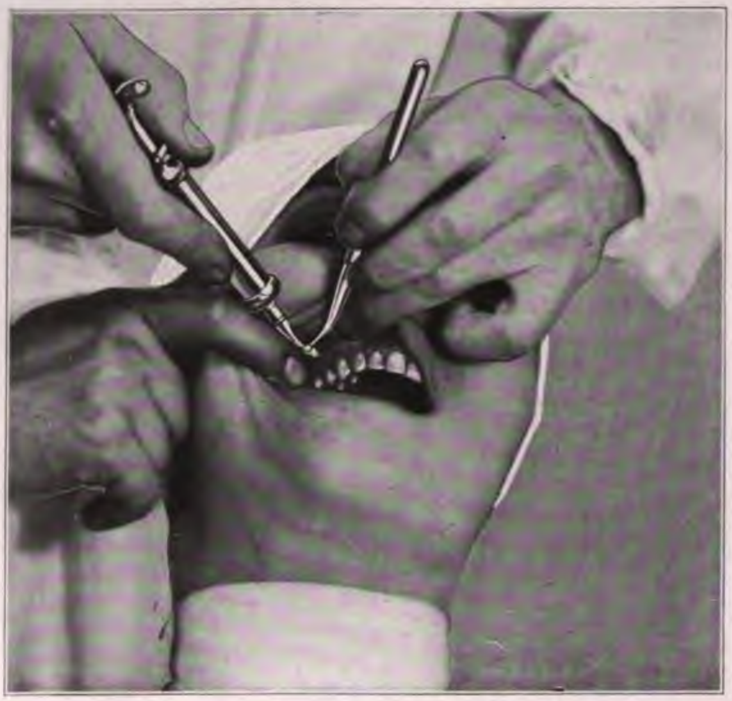


Fig. 288.—Injecting solution into the middle cancellous plate for anesthetizing the upper first and second bicuspids and first molar, alveolar process, and buccal structures.

operator while inserting the needle through the guide and injecting the solution. The operator should be very careful not to bend the needle, and he should also remember that both the syringe and handle of the guide are long levers, and the 3 mm. of the needle which is contained in the bone, is very easily bent. However, considerable pressure can be made upon it without breaking it as it is iridio-platinum.

Injection of Solution.—The total amount of solution injected for blocking the upper bicuspids and first molar, the alveolar process and buccal structures is one and one-half mils plus one-half mil for the preliminary injection. The solution should always be injected very slowly and near the temperature of the body. Perfect contact should be secured between the needle and bone. Care should be exercised not to use excessive pressure upon the plunger and force the solution too quickly from the syringe, as the solution comes in contact with the nerves located in the middle plate of bone. If the solution is cold or extremely hot, it will cause pain when injected in contact with the delicate nerves. After injecting the solution, remove the needle by slightly rotating it. At the time the guide is removed, a solution of three and a half per cent tincture of iodin should be applied by a small cotton applicator to the small opening made by the lancet. (See Fig. 297.) If the operator follows the technic carefully, there will be no laceration or trauma of the parts, and the location of the injection can rarely be detected.

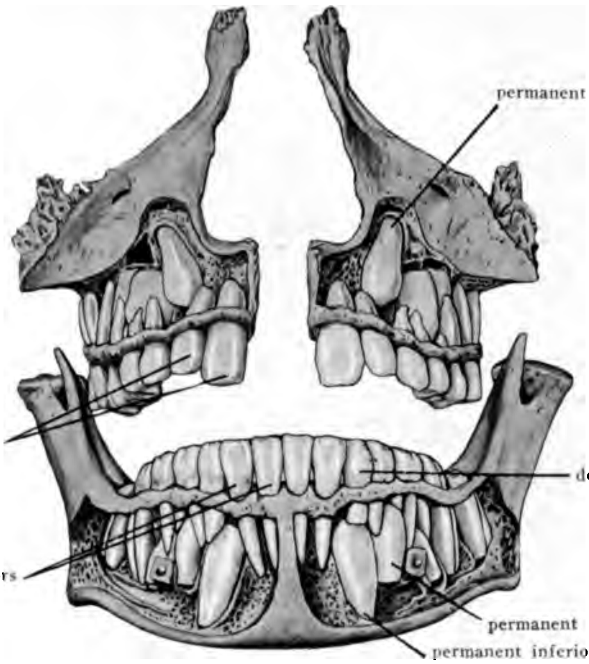

permanent cuspid
permanent superior incisors
deciduous inferior cuspid
permanent inferior incisors
permanent inferior 1st molar
permanent inferior cuspid

Fig. 289.—Upper and lower jaws of a nine year old child seen from in front. The permanent teeth and roots of the deciduous teeth have been exposed by chiseling away the anterior alveolar wall. (From Sobotta and McMurrich.)

Precautions.—It is not inappropriate at this time to reiterate what has already been said with reference to those things which the operator must observe to obtain gratifying results. The intraosseous method of anesthesia is contraindicated in case of alveolar abscess, necrosis, or inflammation. Always observe that the guide is held at right angles to the external alveolar plate while inserting the drill to guard against mutilating the peridental membrane or the root of the tooth. Do not subject the needle or drill to excessive pressure which is caused by exerting lateral force upon the handle of the guide or the syringe, both of which act as levers. Observe that the cutting blades of the double-bladed lancet are in contact with the external alveolar plate, having penetrated the periosteum before releasing the tension, so that the mucosa and periosteum are carefully separated before placing the guide between the blades. Do not allow the guide to move after the drill has been employed. Inject the solution slowly and near the temperature of the body. Always make the injection above or between the apices of the roots of the teeth. It is not advisable to use this method in children for the extraction of deciduous teeth, for the reason there is a possibility of causing injury to the permanent teeth by the drill. (See Fig. 289.) Apply 3½ per cent tincture of iodin to the part at the time the guide and needle are removed.

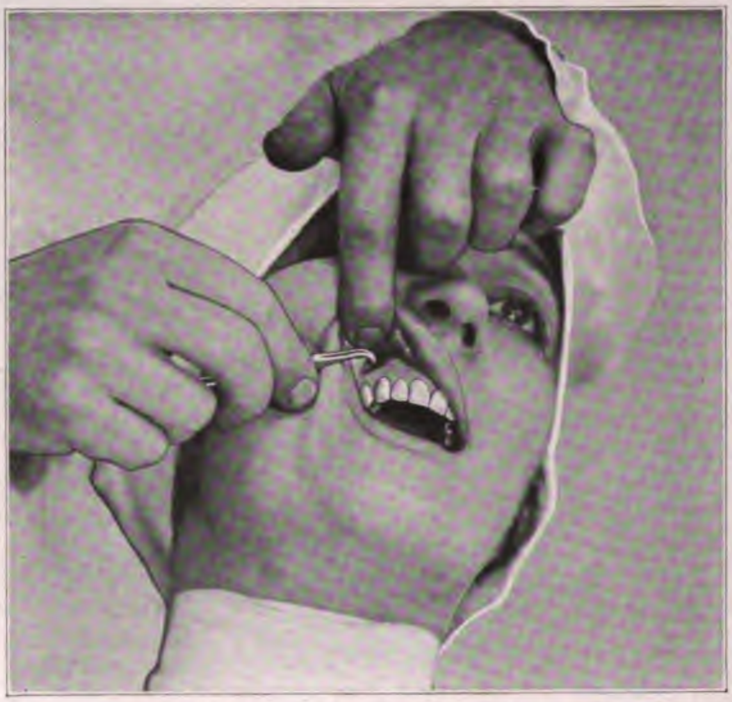


Fig. 290.—Advancing the double-bladed lancet and retractor through the mucous membrane and periosteum at a point distolabial to apex of upper cuspid. This is done following the preliminary injection.

Time to Wait for Anesthesia.—Profound anesthesia is obtained almost immediately following the injection. The reason for immediate anesthesia is that the solution comes in contact with the branches of the middle superior dental nerve.

Structures Anesthetized.—The structures anesthetized following the intraosseous injection depend upon the location and amount of solution injected. With this particular injection, anesthesia is obtained in the upper first and second bicuspids and first molar teeth, alveolar process, buccal periosteum, gum tissue and mucosa. A single intraosseous injection is sufficient for such operations as pulp removal, cavity preparation, shaping the crowns of the teeth for bridge abutments, or any other operation which involves the alveolar process, teeth or buccal tissues. In case the teeth are to be extracted, or if the operation should involve the lingual gum tissue and periosteum, it is in most cases necessary to anesthetize the lingual structures by blocking the anterior palatine nerve. However, in some cases the solution, which is injected into the middle cancellous process, will infiltrate through the lingual plate and produce anesthesia of the lingual structures. The operator should not, however, depend too much upon anesthetizing the lingual structures by an intraosseous injection. In this particular instance, the anterior palatine is not blocked at the posterior palatine foramen, but by injecting the solu-

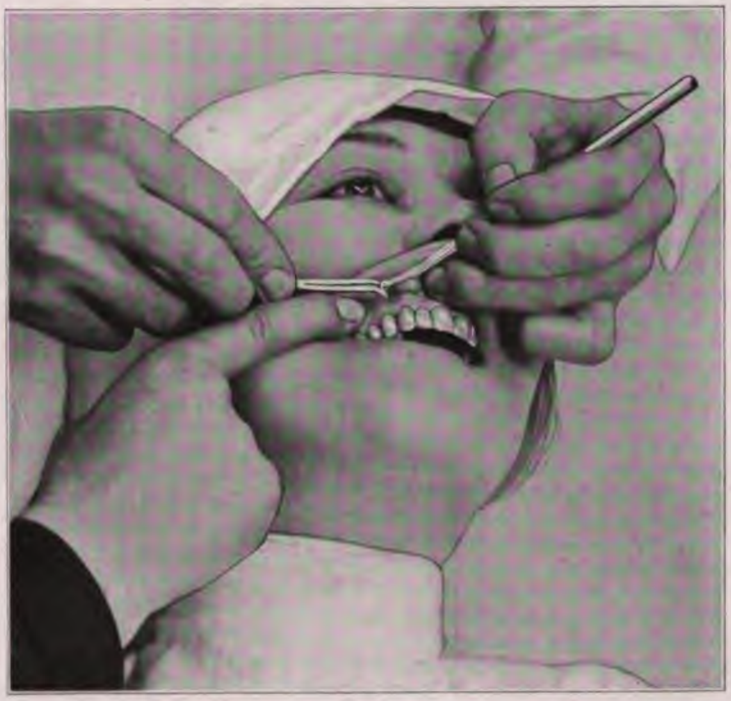


Fig. 291.—Placing the template or guide between the blades of the lancet and retractor and in contact with the external alveolar plate of bone distal to apex of cuspid tooth.

tion midway between the linguo-gingival margin of the upper first molar and median line, or, in other words, lingually to the position occupied by the apex of the lingual root of the upper first molar. (See pages 509 and 510 for technic.)

If the blocking is for an operation upon the upper first or second bicuspids, and the radiogram reveals a definitely outlined granuloma, then two intraosseous injections are advisable. For example, suppose a granuloma of the upper second bicuspid is to be removed, the first intraosseous injection is made above and mesially to the apex of the root of the upper first bicuspid, the second injection either distally and above the distobuccal root of the upper first molar or above and between the apices of the buccal roots of the upper first molar. When two intraosseous injections are made, the anesthetic solution will infiltrate the operative field without inserting the drill and needle in the pathological area which is shown by the radiogram.

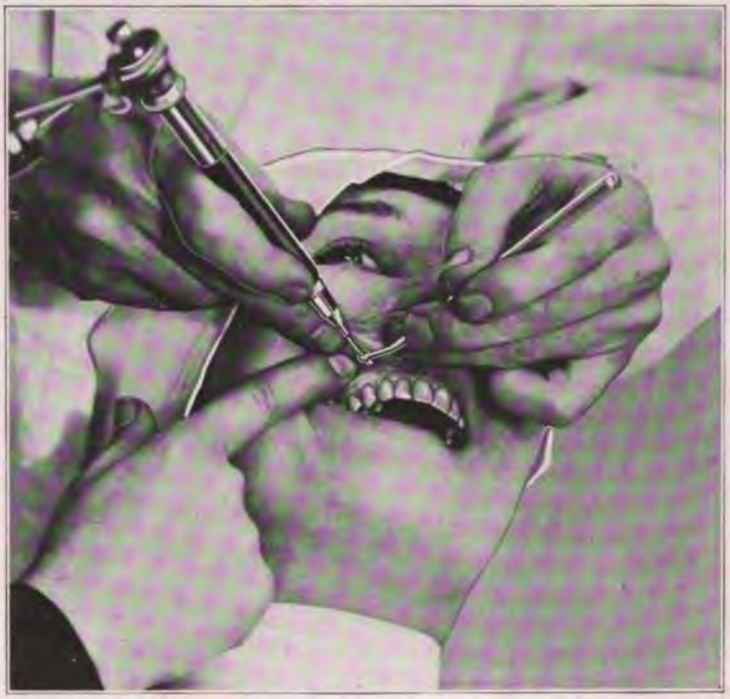


Fig. 292.—Starting the drill through the guide for an intraosseous injection located distolabial to apex of cuspid.

Blocking the Interlacing or Overlapping Branches.—It is not necessary to make an injection to block the interlacing or overlapping nerve branches when the intraosseous method is employed, for the reason that, when the solution is injected by this method, all nerve branches in the operative field are blocked.

Advantages of Author's Technic for Producing Anesthesia by the Intraosseous Method.—

1. The injection can be made without pain to the patient.

2. No trauma or laceration of the tissues is produced because the small blades of the intraosseous lancet and retractor are used to separate the mucous membrane and periosteum.

3. Complete contact between the external alveolar plate and needle is secured with no loss of solution.

4. The amount of solution injected is always known.

5. Postoperative complications are eliminated.

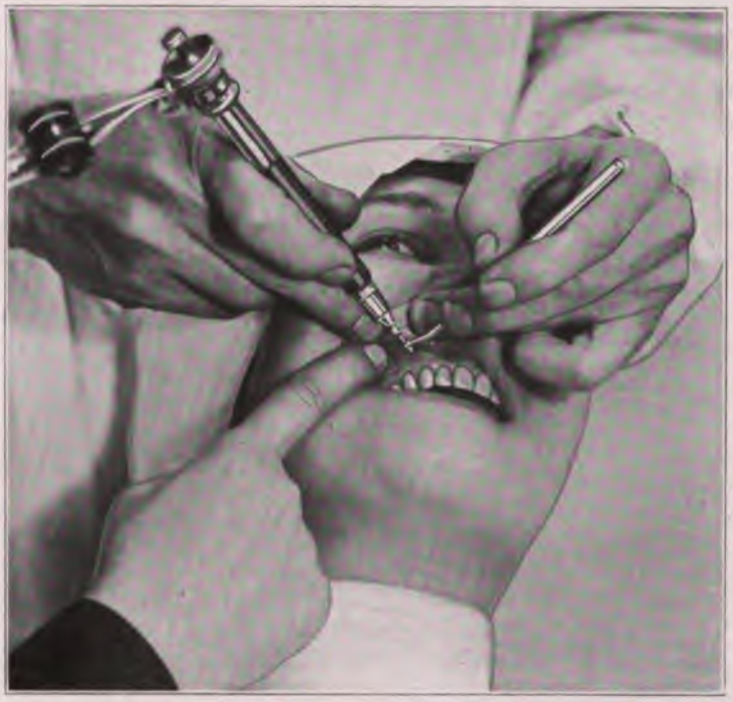


Fig. 293.—Inserting the needle through the guide and external alveolar plate distolabial to apex of cuspid tooth.

6. Anesthesia of the zone injected is secured almost immediately.

7. A minimum amount of solution is required to block a large operative area.

8. One intraosseous injection is in most cases sufficient to block an area which may require additional injections by other methods of local anesthesia.

9. Anesthesia is confined to the immediate operative field.

10. The ease and accuracy with which injections can be made are advantageous.

Blocking the Upper First Molar by the Intraosseous Method.—The technic for blocking the upper first molar by the intraosseous method is identical with what has already been described, with the exception that the injection is made above and between the apices of the buccal roots of the upper first molar, or the injection can be made as previously described; that is, above and between the apex of the second bicuspid root and the mesio-buccal root of the upper first molar. If the injection is made above and buccal to the apices of the buccal roots of the upper first molar, only one mil of solution is required. In most instances it is advisable to make the injection slightly above and distally to the apex of the second bicuspid for operative work upon the first molar, for the reason the buccal roots may be fused, and if such is the case, the drill may pierce them. However, if the upper first molar is to be extracted, the injection can be made buccally and above the apices of the buccal roots of this tooth.

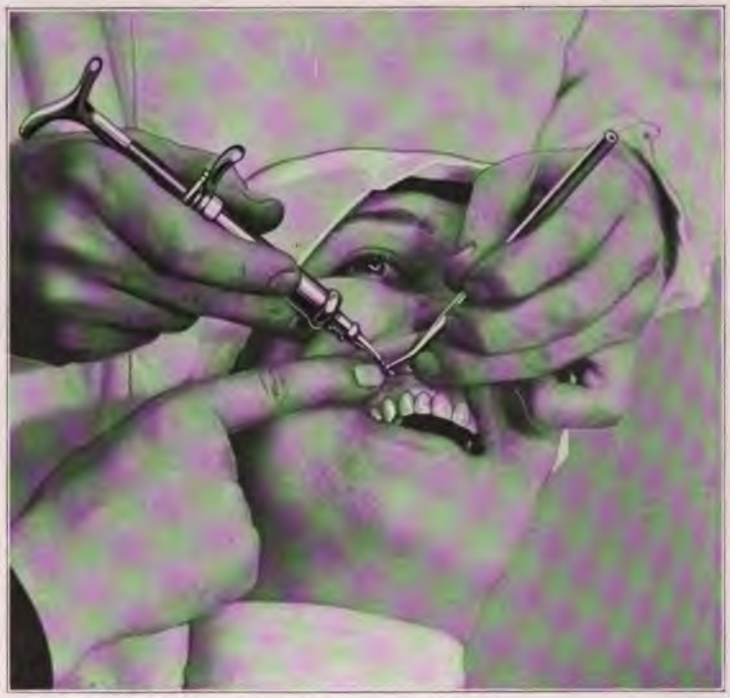


Fig. 294.—Inserting the needle through the template or guide into the small opening which has been made by the drill.

BLOCKING THE UPPER SECOND BICUSPID BY THE INTRAOSSEOUS METHOD

The blocking of this tooth by the intraosseous method is similar to that described above, with the exception that the injection is made above and to the mesial of the apex of the root of the second bicuspid. Inject one mil of the solution.

BLOCKING THE UPPER FIRST BICUSPID BY THE INTRAOSSEOUS METHOD

The injection is made above and to the mesial of the apex of the root of the first bicuspid tooth. The reader will observe that the injection for anesthetizing a single tooth is made anteriorly and above its apex. The reason for this is that the location of injection is nearer the anterior part of the mouth, which adds ease to the technic.

BLOCKING THE INFRAORBITAL; ANTERIOR SUPERIOR DENTAL NERVE AND BRANCHES OF INFRAORBITAL

Topography of Anatomy.—For a thorough description of the anatomy, the reader is referred to Chapter VII. Only a synopsis will be given here.

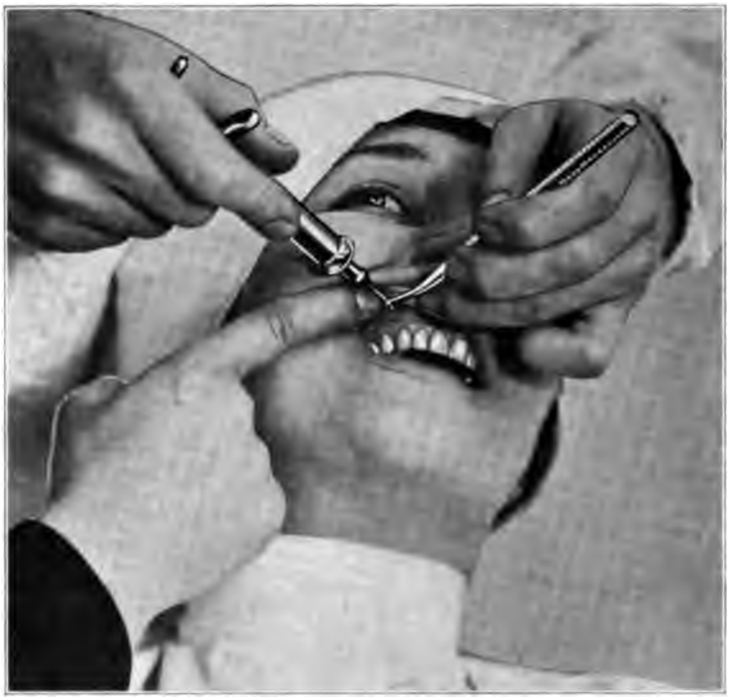


Fig. 295.—Injecting the solution through the guide into the middle cancellous plate of alveolar process.

The infraorbital nerve is a continuation of the second division of the fifth nerve and assumes the name of infraorbital from its location. The second division of the fifth nerve reaches the floor (see Figs. 42, 51, 53, and 68) of the posterior portion of the orbit, and continues anteriorly in the infraorbital groove or sulcus, (see Fig. 37) then enters the infraorbital canal and makes its exit upon the anterior surface of the superior maxillary bone through the infraorbital foramen. (See Figs. 32, 40, 60, 69 and 70.) The infraorbital nerve is of considerable diameter, and after it passes through the infraorbital foramen, it divides into three principal branches as given below.

The object of injecting the solution at the infraorbital foramen is to block the anterior superior dental and the terminal branches of the infraorbital nerve which are the inferior palpebral, lateral nasal and superior labial. The anterior superior dental nerve (see Figs. 40 and 60) arises from the infraorbital nerve approximately 5 mm. distal to the opening of the infraorbital foramen. Its direction is downward and inward in a bony canal or groove located beneath the periosteum and mucous membrane lining the anterior wall of the antrum. It divides into small branches which supply the upper cuspid, lateral and central incisor teeth, a portion of the

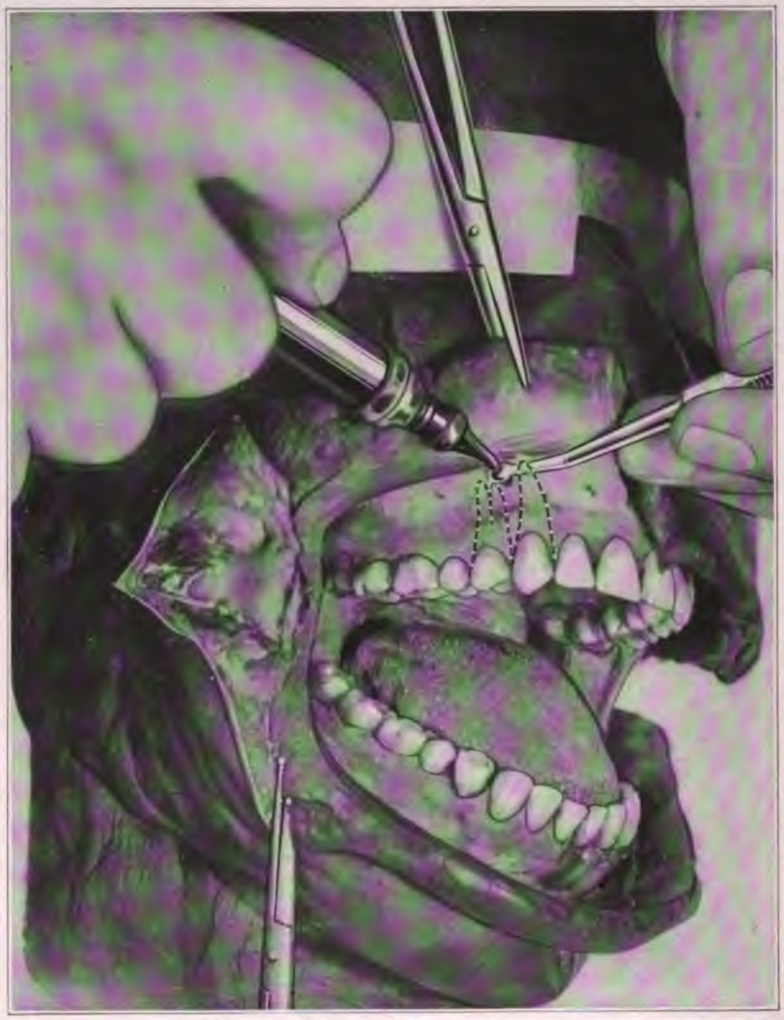


Fig. 296.—Showing exact position for making an intraosseous injection for the blocking of two or more teeth. Note that the solution is injected slightly above and between the apices of the teeth.

superior maxillary bone, alveolar process, labial alveolar plate, periosteum, gum tissue, and labial mucosa. It sends communicating branches which unite with the middle superior dental (see Figs. 40 and 60) to form the superior dental plexus, and also branches which cross the median line to communicate with its fellow on the opposite side. This nerve forms the anterior portion of the outer nerve loop; it can not be reached directly with the needle, because it is situated beneath the anterior wall of the superior maxillary bone, and the nearest point to which this nerve branch can be reached with the solution is at the opening of the infraorbital foramen. (See Figs. 32, 37, and 76 for infraorbital foramen.)

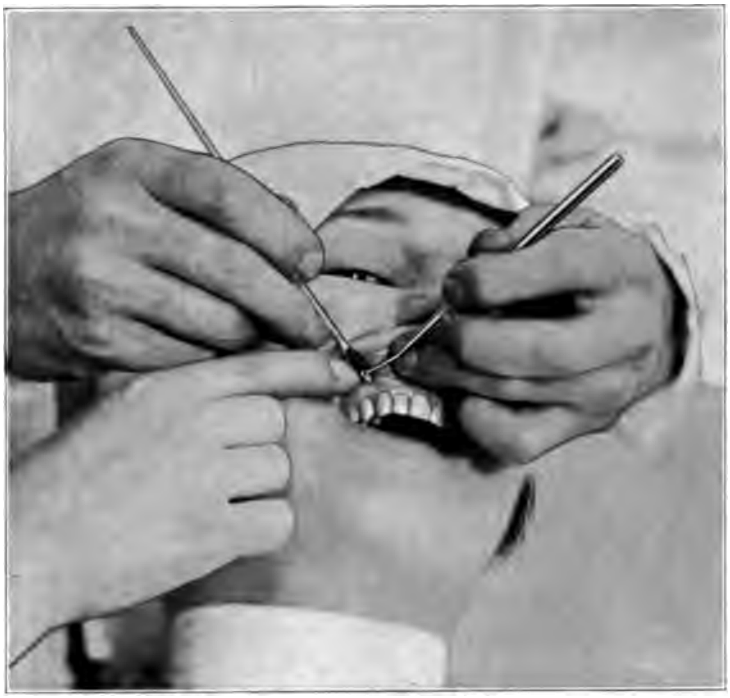


Fig. 297.—Applying the germicidal solution to tissue at point of intraosseous injection as the template or guide is removed.

The naming of this injection "The Infraorbital" is not technically correct, if all injections are named after the nerve branch, which has been advised by the author. A more scientific name would be the "Anterior Superior Dental Injection."

Immediately after the infraorbital nerve emerges from the infraorbital foramen, it forms a plexus which divides into three branches which supply the lower eyelid, skin, the cartilage of the side of the nose and half of the upper lip. These three branches have nothing to do with the nerve supply of the region occupied by the central, lateral and cuspid teeth. When the solution is injected at the opening of the infraorbital foramen, anesthesia is produced in a portion of the infraorbital nerve, infraorbital plexus, the three terminal facial branches, and the anterior superior dental nerve. For operative dentistry, the object of discharging the solution at the infraorbital foramen is to block the anterior superior dental nerve which is given off the infraorbital nerve in the infraorbital canal at a point approximately 5 mm. to the distal of the opening of the infraorbital foramen. When the solution is injected at the infraorbital foramen, it is impossible to anesthetize the anterior superior dental nerve without first producing anesthesia of the inferior palpebral, lateronasal and superior labial branches, and a portion of the infraorbital nerve. The anatomical arrangement makes it impossible to block the anterior superior dental nerve directly with the

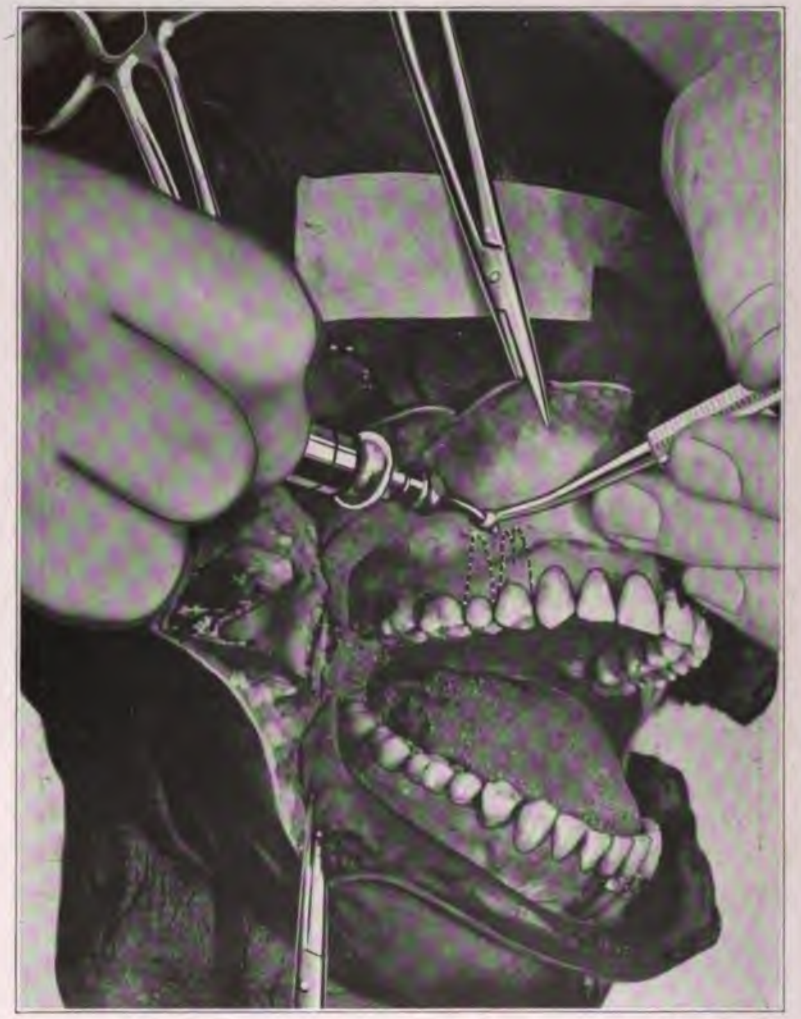


Fig. 298.—Position of intraosseous injection for blocking the two superior bicuspids or additional teeth.

needle; therefore, the solution is injected at the opening of the foramen, and then by careful massaging, the solution is forced backward into the infraorbital canal, thus reaching the anterior superior dental branch.

Osteology of the Anterior Surface of the Superior Maxillary Bone.—The anterior surface of the superior maxillary bone is concave in the region of the cuspid fossa, (see Figs. 35, 36 and 37) which makes it absolutely impossible for the needle to follow the periosteum from the starting point until the foramen is reached, but instead of trying to follow the periosteum this concave surface must be bridged by the needle. (See Fig. 307.) The infraorbital foramen is located approximately 1 cm. below the infraorbital margin and at the junction of the second and third fifths. The reader is referred to any standard textbook of anatomy to thoroughly acquaint himself with the osteology of the parts involved.

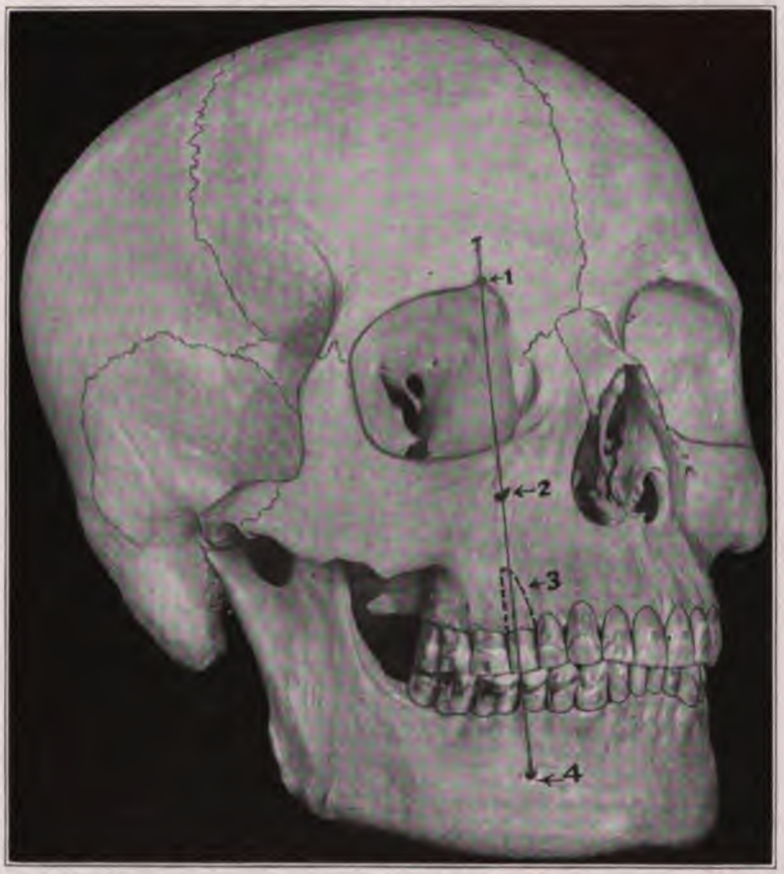


Fig. 299.—Illustrating the line drawn through the long axis of the second bicuspid which in most cases will pass through the following foramina:

1, Supraorbital foramen; 2, infraorbital foramen; 3, root of upper second bicuspid; 4, mental foramen.

Location of the Infraorbital Foramen.—With the teeth in occlusion, a line drawn through the long axis of the second bicuspid tooth (provided the patient has normal occlusion), will pass through the infraorbital foramen, the supraorbital foramen and mental foramen. Figs. 299 and 300 illustrate a line which has been drawn in the above described manner. If this point be borne in mind while inserting the needle for injecting the solution at the infraorbital foramen, the operator will find it to be highly advantageous. Both the supraorbital and infraorbital foramina are located at the junction of the second and third fifths. Divide the infraorbital margin into fifths, then place the tip of the index finger one centimeter below the infraorbital margin between the second and third fifths nearest the median line, and it will rest directly over the infraorbital foramen. (See Fig. 301.) In some cases this line will not bisect the infraorbital and supraorbital foramina, but may pass the mesial or lateral margins of the foramina, but for all practical purposes it makes little or no difference.

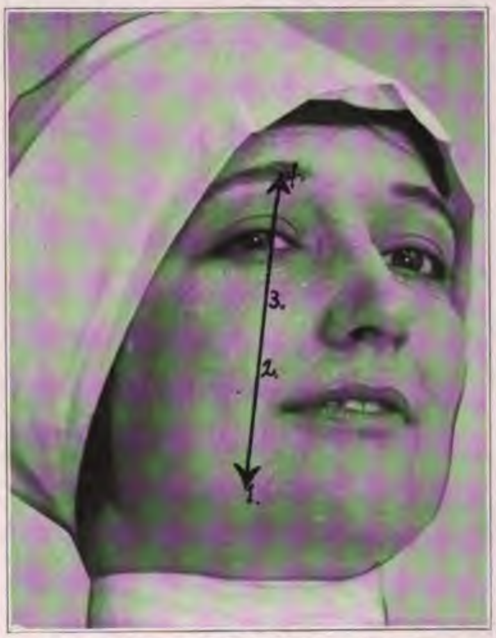


Fig. 300.—A line drawn through the long axis of the second bicuspid, will in most cases pass through the mental foramen indicated by 1; the second bicuspid indicated by 2; the infraorbital foramen indicated by 3 and supraorbital foramen indicated by 4.

Needle Employed.—The needle employed for injecting the solution at the infraorbital foramen is No. 4, 25 gauge, 3 cm. in length. (See Fig. 177.) The average depth of the needle while making the injection is 2 cm., the needle being 3 cm. in length, therefore, 1 cm. will remain external to the tissue.

Technic of Injection.—The chair should be elevated and tipped backward with the patient in a semi-supine position. (See Fig. 570.) The operator should stand in front and at the side of his patient. The area of injection is now carefully prepared as described on page 355. Locate the infraorbital margin of the superior maxillary and malar bones with the tip of the index finger. Palpate the infraorbital margin, and after carefully locating it, divide the infraorbital margin into fifths, and starting from the median side, place the tip of the finger 1 cm. beneath the infraorbital margin at the junction of the second and third fifths. (See Figs. 301, 308, 309, and 312.) An imaginary line is now drawn through the long axis of the second bicuspid which will pass through the infraorbital, supraorbital and mental foramina. (See Figs. 299 and 300.) The index finger should rest directly over the infraorbital foramen, and the upper lip and angle of the mouth should be raised with the thumb to thoroughly expose the area which is to receive the needle. (See Fig. 302.)

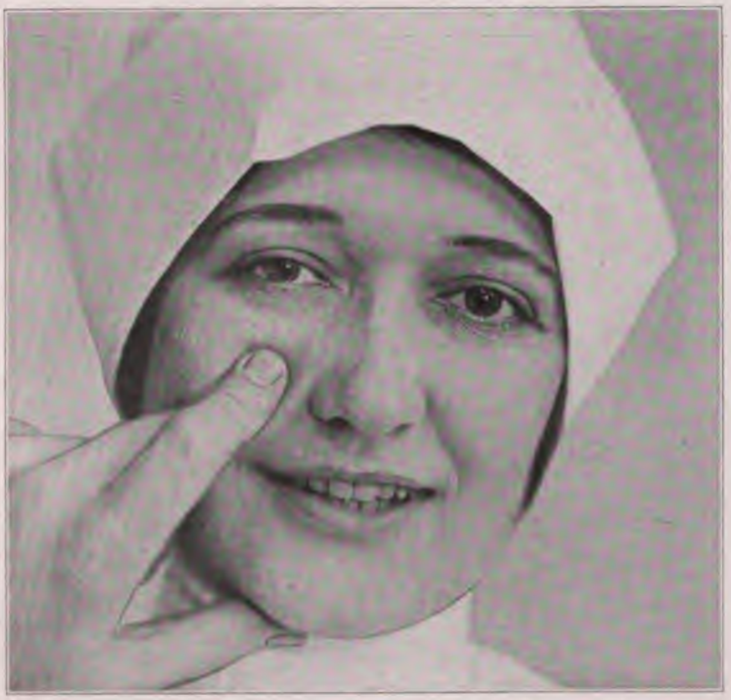


Fig. 301.—Placing the index finger in the region of the infraorbital foramen.

The syringe is held in the right hand pen fashion. The operator should not be too hasty in inserting the needle, but should take a few moments to obtain correct alignment of the course which the needle is going to take. After a correct alignment has been obtained, hold the syringe and needle parallel to the buccal of the long axis of the upper second bicuspid and puncture the mucosa above and buccally to the apex of the upper second bicuspid, that is, at the highest point. (See Figs. 302, 303, 310.) The operator should exercise caution in observing that the needle is held parallel to the long axis of the second bicuspid, provided this tooth is in its normal location. (See Figs. 303, 304.) In case the patient does not possess normal occlusion, insert the needle as near as possible to the normal location of the second bicuspid tooth. If the operator understands the technic of this injection when the second bicuspid is in normal occlusion, it should be a simple matter to modify the technic in an abnormal case. The needle puncture in the mucosa should be located at least 1 cm. from the external alveolar plate. (See Fig. 307.) The needle should be slowly and carefully advanced towards the infraorbital foramen in the manner described above. (See Figs. 305, 306, [illegible], and [illegible].) It should not touch the periosteum until the infraorbital foramen is reached. Too much emphasis can not be placed upon this important phase of the technic, for if the needle is allowed to follow the periosteum, failure is sure to occur, because the surface osteology of this part contraindicates such a procedure. The cuspid fossa (see Figs. 32 and 35) which is located in this region, is concave, and if

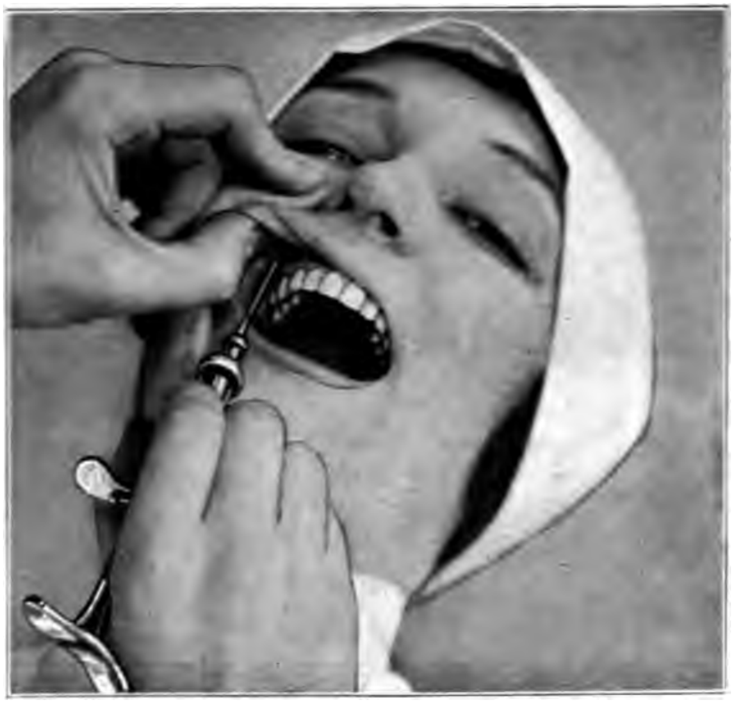


Fig. 302. Position of syringe and needle for the infraorbital injection. Index finger placed directly over infraorbital foramen. The thumb is raising the lip.

the periosteum is followed, the needle will become engaged beneath the periosteum in the floor of the cuspid fossa, with the result that the solution is injected below the infraorbital foramen, instead of at the opening of the foramen. (See Fig. 313.) Fischer's technic is to insert the needle in the region of the apex of the cuspid and advance it towards the infraorbital foramen at an angle.

Many operators have failed to block the anterior superior dental nerve because they started the needle in the gum tissue or in the mucosa, and forced it upward in contact with the periosteum covering the anterior surface of the superior maxillary bone. If such technic is employed, the needle will enter the floor of the cuspid fossa, making it impossible to advance the needle farther without bending or breaking it. A common mistake with many operators is to inject the solution in the cuspid fossa located 1 cm. beneath the infraorbital foramen. (See Fig. 313.) When the solution is injected in the cuspid fossa, it is impossible to force it into the infraorbital canal by massage. It should be borne in mind that when the solution is injected at the opening of the infraorbital foramen, it must travel posteriorly approximately 5 mm. through the infraorbital canal to anesthetize the anterior superior dental nerve (see Figs. 40 and 60). The needle should reach the periosteum near the opening of the infraorbital foramen at an approximate depth of two centimeters. (See Figs. 305, 306, and 308.) The bevel of the needle should be towards the periosteum. The needle bridges the cuspid

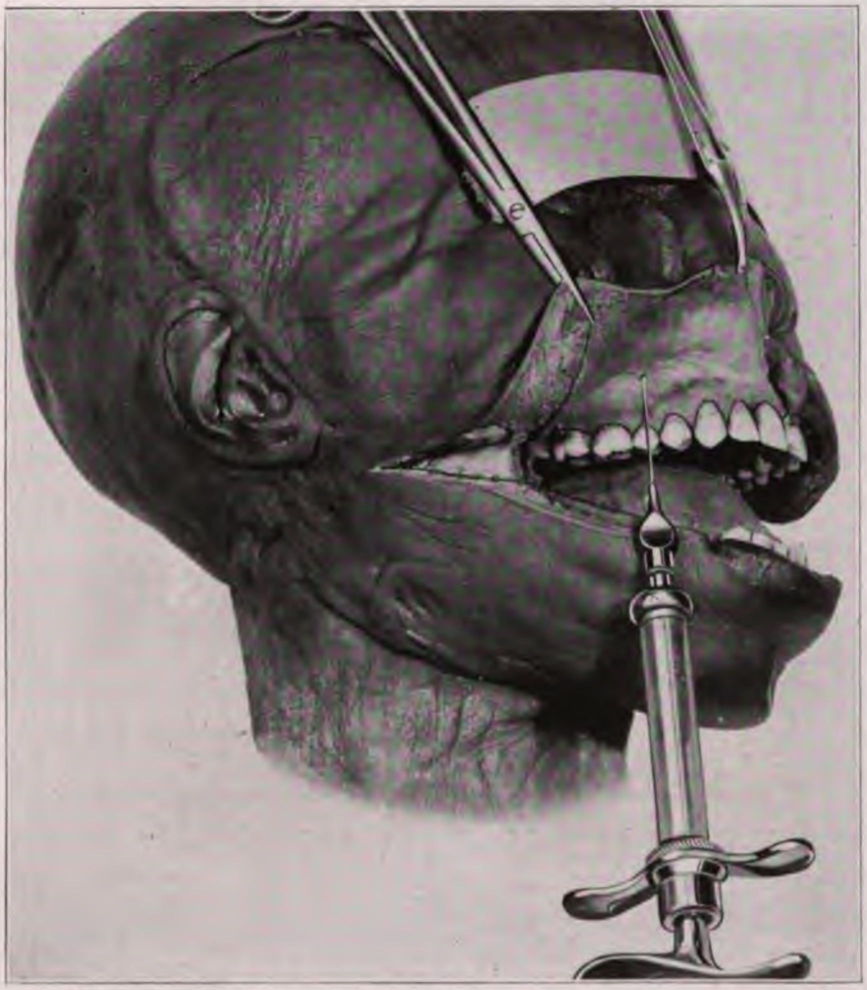
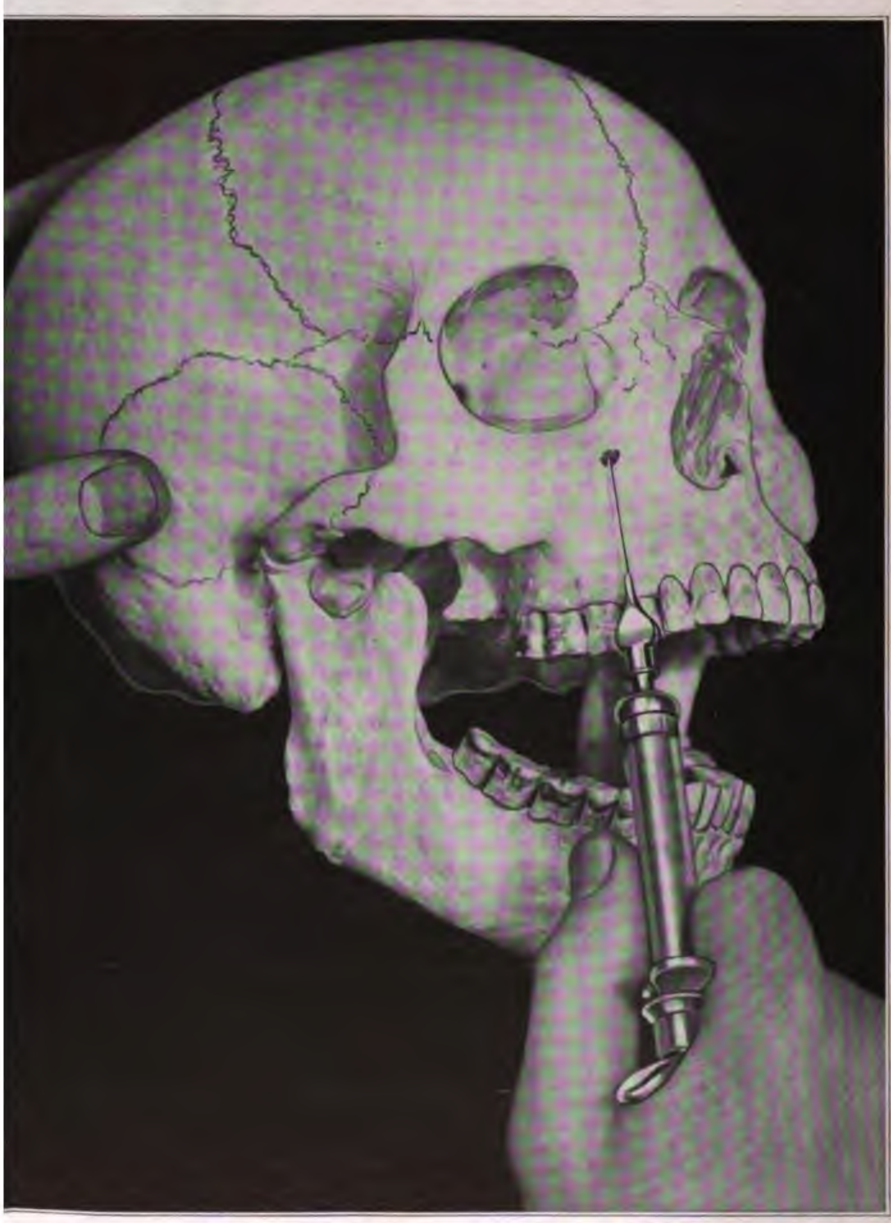


Fig. 303.—Wet anatomical specimen illustrating the starting point of the needle for blocking the anterior superior dental, infraorbital nerve and branches at the infraorbital foramen. Needle is started in the mucous membrane buccal to apex of second bicuspid.

and does not come in contact with the periosteum at any point until it s the area near the infraorbital foramen. Fig. 307 shows a lateral view needle, and it is noted that there is a considerable distance between the e and the anterior surface of the superior maxillary bone. In most cases istance is, at least, 1 cm. between the needle and cuspid fossa. In case any ance is shown by the patient, it is good practice to inject the solution



4.—Illustrating the needle in region of the infraorbital foramen. Needle is held parallel to long axis of second bicuspid.

from the time the needle enters the tissue until the foramen is reached. A few minims can be discharged while the needle is passing through the tissue, stopping the needle at various intervals and waiting a few seconds before advancing it. However, in nearly every case the infraorbital injection is made without any pain whatsoever.

After two mils of solution are injected at the foramen, the skin around the foramen is massaged in a circular fashion, which will force the solution through the infraorbital canal, thus reaching the anterior superior dental nerve. The part should be massaged for at least one minute, but excessive manipulation should not be practiced as it may cause postoperative soreness, or even produce ecchymosis, especially in a woman who possesses tender skin.

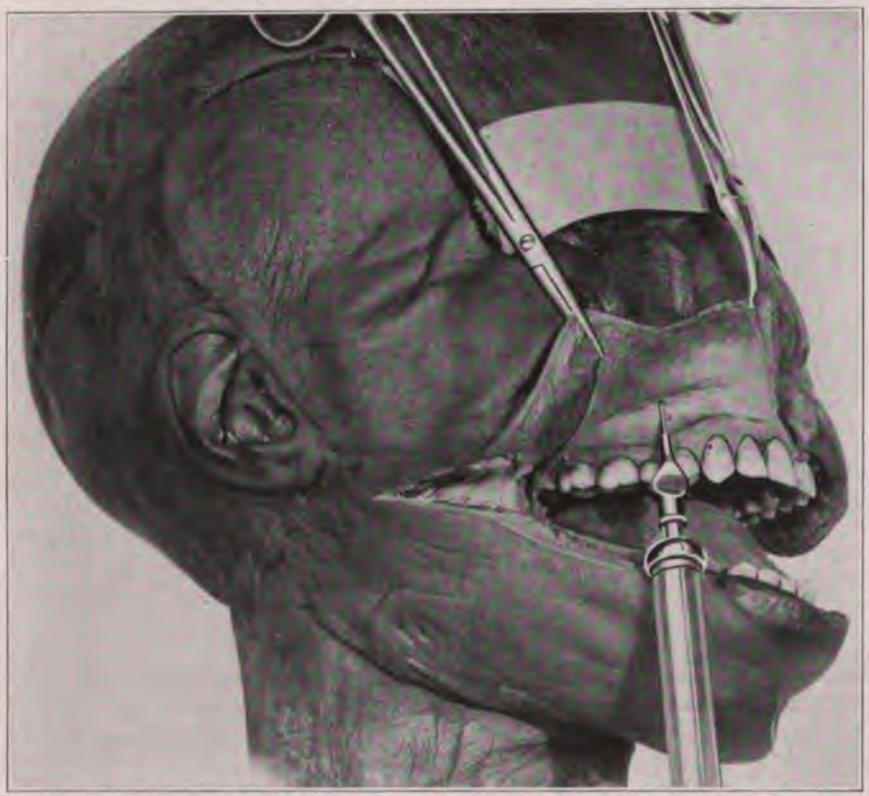


Fig. 305.—Position of the needle while the point is in contact with the periosteum near the infraorbital foramen. Approximately two centimeters of the needle are inserted in the tissue while one centimeter is located exterior to the puncture point.

Injection of Solution.—The amount of solution injected at the infraorbital foramen is two mils. It is advisable to fill the syringe with two and a half mils so as to allow for preliminary injection if needed. With the tip of the index finger placed directly over the infraorbital foramen, the operator will immediately detect the presence of the solution which is being slowly discharged, as it will distend the tissues located exterior to the foramen.

While discharging the solution it is advantageous to manipulate the needle back and forth through a distance of 2 or 3 mm. for the purpose of aiding the solution in leaving the syringe.

Precautions.—Hundreds of operators have informed the author that they have experienced more difficulty in blocking the anterior superior dental than any other nerve branch, except the middle superior dental nerve. The principal reason why so many operators have failed with this injection is that they have attempted to follow the periosteum with the needle and, as a result, the infraorbital foramen has never been reached, and the solution has been injected below the desired location. In other words, the solution was deposited in the floor of the cuspid fossa (see Fig. 313). When the solution is injected in this manner, it matters not how much massaging is done, there will not be enough of the solution to enter the opening of the infraorbital foramen and canal to block the anterior superior dental nerve. The solution will follow the lines of least resistance, and when it is discharged on the anterior surface of the superior maxillary bone and massaging is done, it will infiltrate in all directions, producing an excellent anesthesia of the inferior palpebral, lateronasal and superior labial nerves, which means nothing so far as operative dentistry is concerned, for the reason that these nerves do not supply the teeth or alveolar process. (See Figs. 60, 309, and 312.)

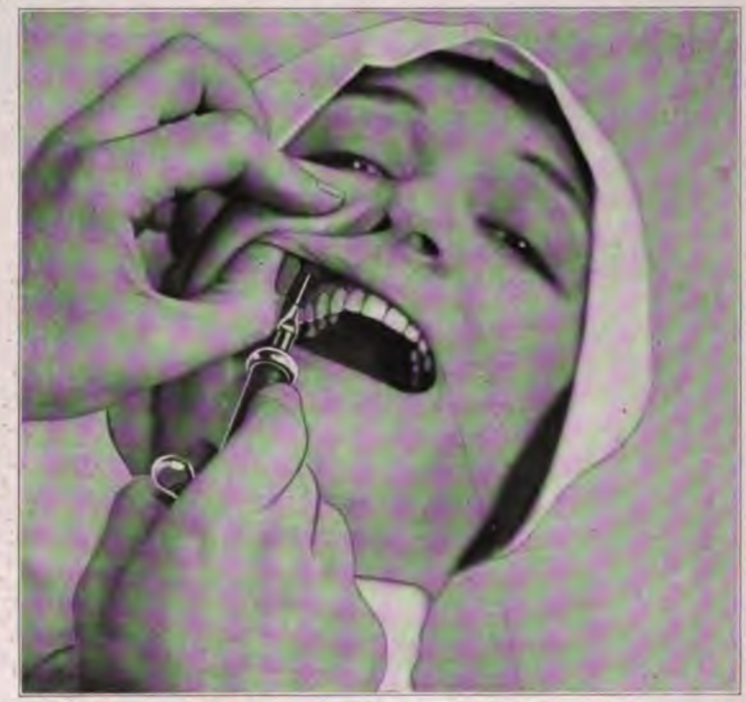


Fig. 306.—Showing position of needle which is parallel to the long axis of the second bicuspid while discharging the solution at the infraorbital foramen. The index finger is resting directly over the foramen while the thumb is raising the lip.

The operator should be very cautious in observing that the point of the needle is located at the opening of the infraorbital foramen before the solution is discharged, and when the solution is discharged at this point and the massaging is correctly done, sufficient solution will pass backward into the infraorbital canal to produce profound anesthesia of the anterior superior dental nerve, which supplies the central, lateral and cuspid teeth and other structures.

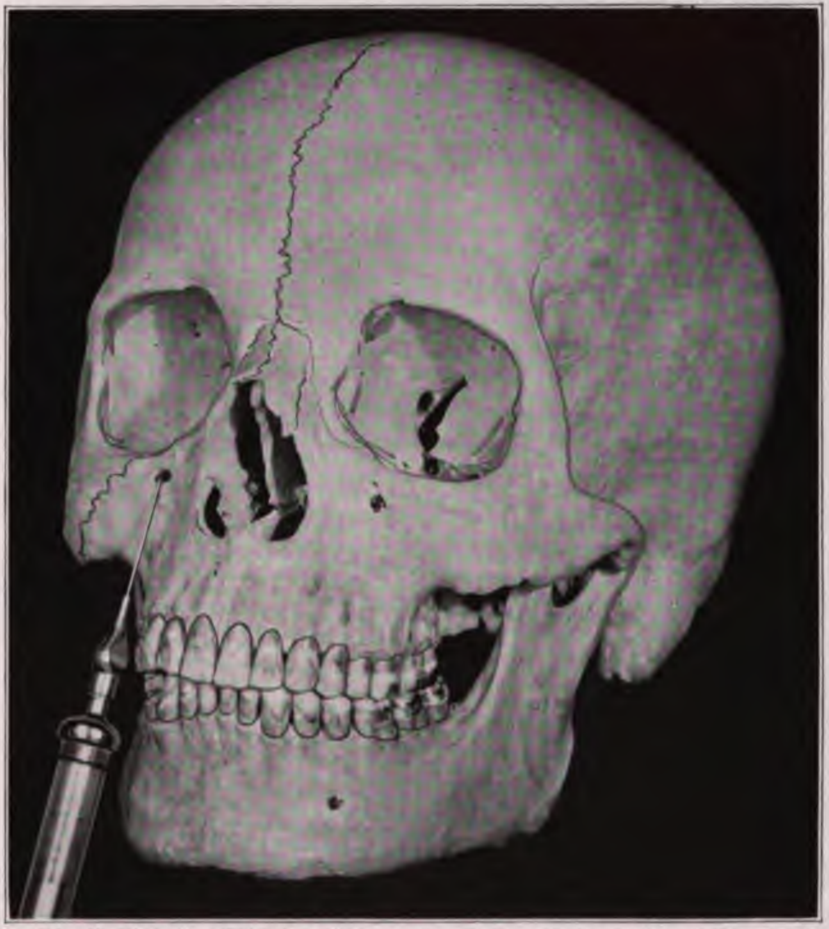


Fig. 307.—Showing the relationship of the needle and the anterior surface of the superior maxillary bone. The needle does not strike the periosteum until the region of the foramen is reached. The needle bridges the cuspid fossa.

Another common mistake which is made by many operators is that of not advancing the needle upward parallel to the long axis of the upper second bicuspid towards the infraorbital foramen. The usual practice is to allow the needle to form an acute angle with the external surface of the superior maxillary bone. (See Fig. 313.) The author desires to place much emphasis upon this particular phase of the technic, inasmuch as it means so much to the successful outcome of the infraorbital injection. Greater care should be exercised in the execution of the technic in the making of the infraorbital produced in a portion of the infraorbital nerve, infraorbital plexus, the three terminal facial branches, and the anterior superior dental nerve. For operative dentistry, the object of discharging the solution at the infraorbital foramen is to block the anterior superior dental nerve which is given off the infraorbital nerve in the infraorbital canal at a point approximately 5 mm. to the distal of the opening of the infraorbital foramen. When the solution is injected at the infraorbital foramen, it is impossible to anesthetize the anterior superior dental nerve without first producing anesthesia of the inferior palpebral, lateronasal and superior labial branches, and a portion of the infraorbital nerve. The anatomical arrangement makes it impossible to block the anterior superior dental nerve directly with the

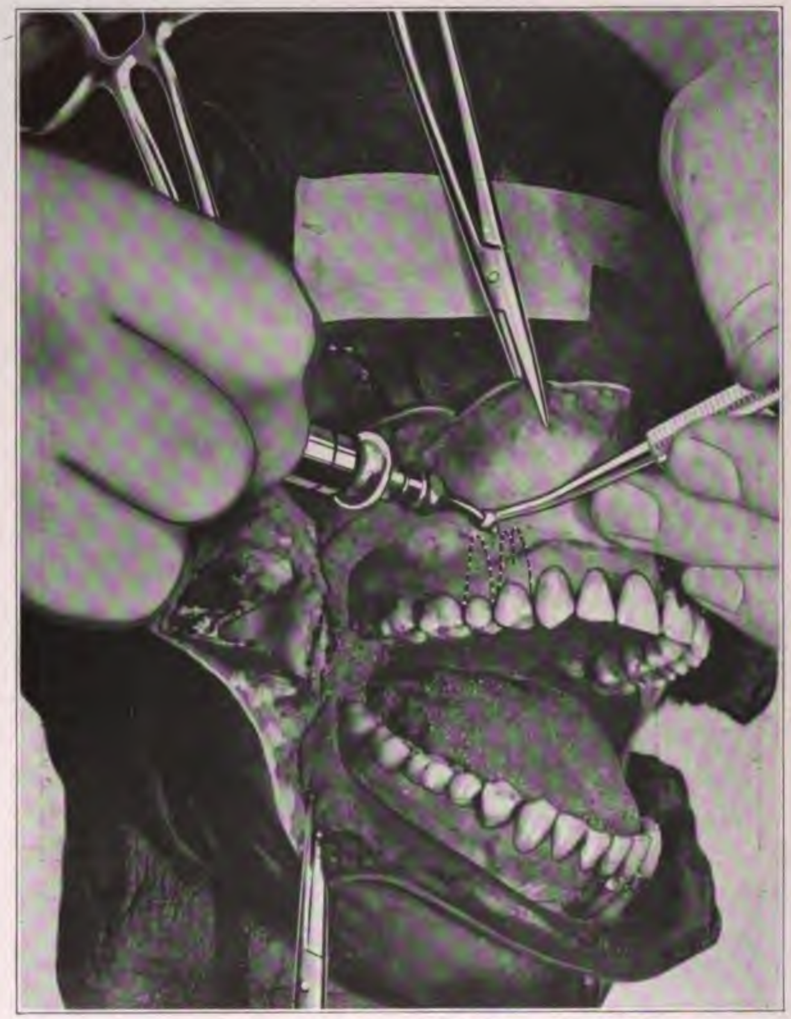


Fig. 298.—Position of intraosseous injection for blocking the two superior bicuspids or additional teeth.

needle; therefore, the solution is injected at the opening of the foramen, and then by careful massaging, the solution is forced backward into the infraorbital canal, thus reaching the anterior superior dental branch.

Osteology of the Anterior Surface of the Superior Maxillary Bone.—The anterior surface of the superior maxillary bone is concave in the region of the cuspid fossa, (see Figs. 35, 36 and 37) which makes it absolutely impossible for the needle to follow the periosteum from the starting point until the foramen is reached, but instead of trying to follow the periosteum this concave surface must be bridged by the needle. (See Fig. 307.) The infraorbital foramen is located approximately 1 cm. below the infraorbital margin and at the junction of the second and third fifths. The reader is referred to any standard textbook of anatomy to thoroughly acquaint himself with the osteology of the parts involved.

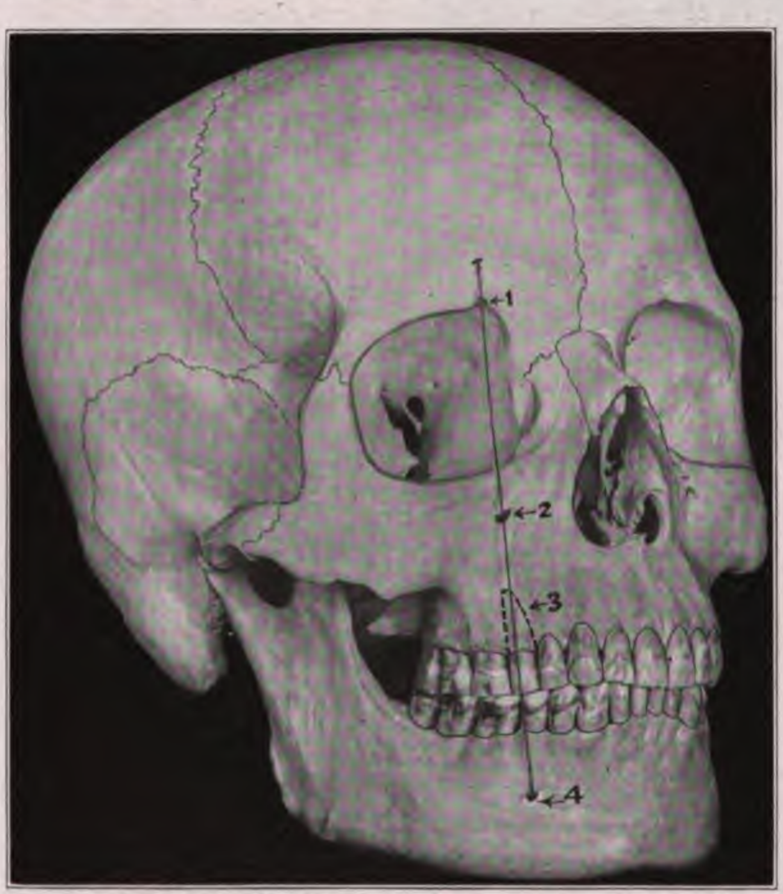


Fig. 299.—Illustrating the line drawn through the long axis of the second bicuspid which in most cases will pass through the following foramina:

1, Supraorbital foramen; 2, infraorbital foramen; 3, root of upper second bicuspid; 4, mental foramen.

Location of the Infraorbital Foramen.—With the teeth in occlusion, a line drawn through the long axis of the second bicuspid tooth (provided the patient has normal occlusion), will pass through the infraorbital foramen, the supraorbital foramen and mental foramen. Figs. 299 and 300 illustrate a line which has been drawn in the above described manner. If this point be borne in mind while inserting the needle for injecting the solution at the infraorbital foramen, the operator will find it to be highly advantageous. Both the supraorbital and infraorbital foramina are located at the junction of the second and third fifths. Divide the infraorbital margin into fifths, then place the tip of the index finger one centimeter below the infraorbital margin between the second and third fifths nearest the median line, and it will rest directly over the infraorbital foramen. (See Fig. 301.) In some cases this line will not bisect the infraorbital and supraorbital foramina, but may pass the mesial or lateral margins of the foramina, but for all practical purposes it makes little or no difference.

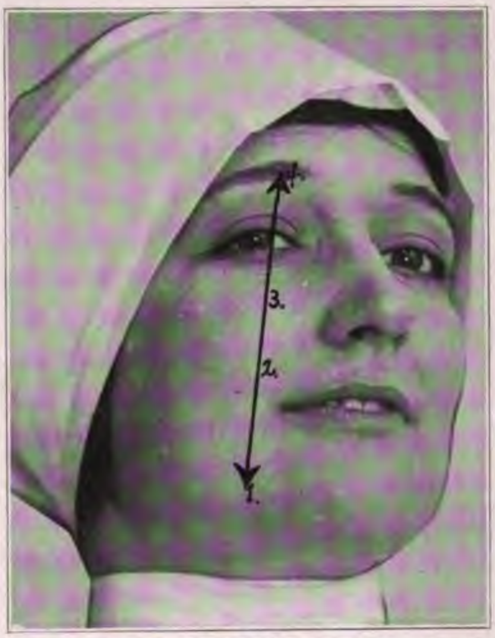


Fig. 300.—A line drawn through the long axis of the second bicuspid, will in most cases pass through the mental foramen indicated by 1; the second bicuspid indicated by 2; the infraorbital foramen indicated by 3 and supraorbital foramen indicated by 4.

Needle Employed.—The needle employed for injecting the solution at the infraorbital foramen is No. 4, 25 gauge, 3 cm. in length. (See Fig. 177.) The average depth of the needle while making the injection is 2 cm., the needle being 3 cm. in length, therefore, 1 cm. will remain external to the tissue.

Technic of Injection.—The chair should be elevated and tipped backward with the patient in a semi-supine position. (See Fig. 570.) The operator should stand in front and at the side of his patient. The area of injection is now carefully prepared as described on page 355. Locate the infraorbital margin of the superior maxillary and malar bones with the tip of the index finger. Palpate the infraorbital margin, and after carefully locating it, divide the infraorbital margin into fifths, and starting from the median side, place the tip of the finger 1 cm. beneath the infraorbital margin at the junction of the second and third fifths. (See Figs. 301, 308, 309, and 312.) An imaginary line is now drawn through the long axis of the second bicuspid which will pass through the infraorbital, supraorbital and mental foramina. (See Figs. 299 and 300.) The index finger should rest directly over the infraorbital foramen, and the upper lip and angle of the mouth should be raised with the thumb to thoroughly expose the area which is to receive the needle. (See Fig. 302.)

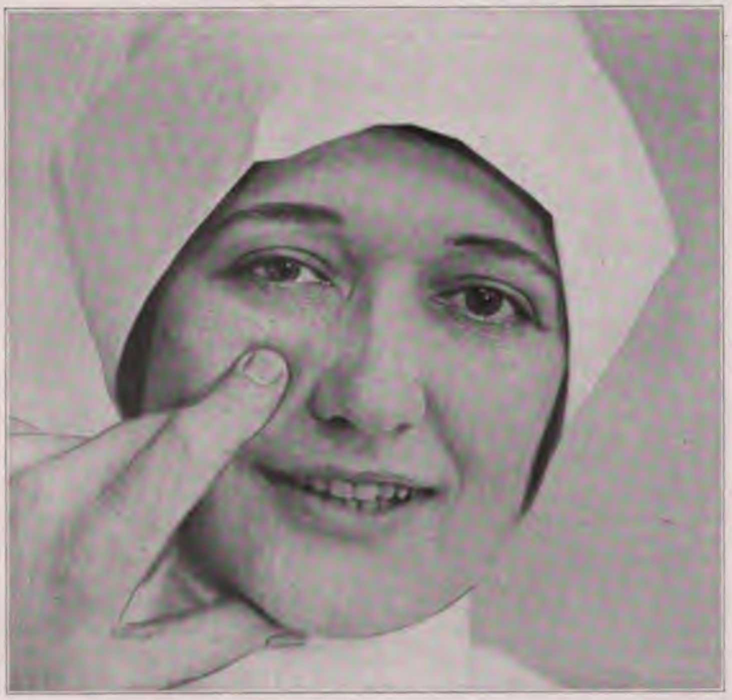


Fig. 301.—Placing the index finger in the region of the infraorbital foramen.

The syringe is held in the right hand pen fashion. The operator should not be too hasty in inserting the needle, but should take a few moments to obtain correct alignment of the course which the needle is going to take. After a correct alignment has been obtained, hold the syringe and needle parallel to the buccal of the long axis of the upper second bicuspid and puncture the mucosa above and buccally to the apex of the upper second bicuspid, that is, at the highest point. (See Figs. 302, 303, 310.) The operator should exercise caution in observing that the needle is held parallel to the long axis of the second bicuspid, provided this tooth is in its normal location. (See Figs. 303, 304.) In case the patient does not possess normal occlusion, insert the needle as near as possible to the normal location of the second bicuspid tooth. If the operator understands the technic of this injection when the second bicuspid is in normal occlusion, it should be a simple matter to modify the technic in an abnormal case. The needle puncture in the mucosa should be located at least 1 cm. from the external alveolar plate. (See Fig. 307.) The needle should be slowly and carefully advanced towards the infraorbital foramen in the manner described above. (See Figs. 305, 306, 308, and 309.) It should not touch the periosteum until the infraorbital foramen is reached. Too much emphasis can not be placed upon this important phase of the technic, for if the needle is allowed to follow the periosteum, failure is sure to occur, because the surface osteology of this part contraindicates such a procedure. The cuspid fossa (see Figs. 32 and 35) which is located in this region, is concave, and if the periosteum is followed, the needle will become engaged beneath the periosteum in the floor of the cuspid fossa, with the result that the solution is injected below the infraorbital foramen, instead of at the opening of the foramen. (See Fig. 313.) Fischer's technic is to insert the needle in the region of the apex of the cuspid and advance it towards the infraorbital foramen at an angle.

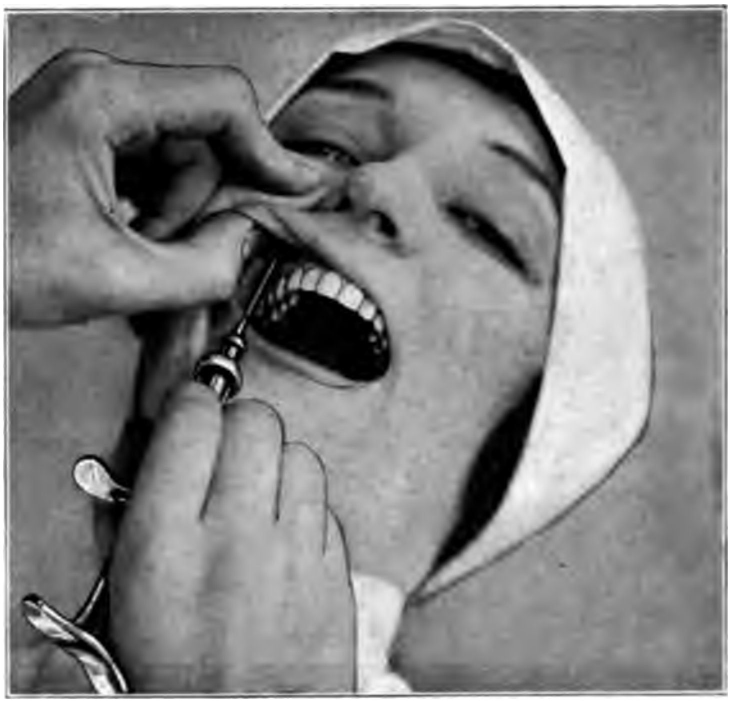


Fig. 302.—Position of syringe and needle for the infraorbital injection. Index finger placed directly over infraorbital foramen. The thumb is raising the lip.

Many operators have failed to block the anterior superior dental nerve because they started the needle in the gum tissue or in the mucosa, and forced it upward in contact with the periosteum covering the anterior surface of the superior maxillary bone. If such technic is employed, the needle will enter the floor of the cuspid fossa, making it impossible to advance the needle farther without bending or breaking it. A common mistake with many operators is to inject the solution in the cuspid fossa located 1 cm. beneath the infraorbital foramen. (See Fig. 313.) When the solution is injected in the cuspid fossa, it is impossible to force it into the infraorbital canal by massage. It should be borne in mind that when the solution is injected at the opening of the infraorbital foramen, it must travel posteriorly approximately 5 mm. through the infraorbital canal to anesthetize the anterior superior dental nerve (see Figs. 40 and 60). The needle should reach the periosteum near the opening of the infraorbital foramen at an approximate depth of two centimeters. (See Figs. 305, 306, and 308.) The bevel of the needle should be towards the periosteum. The needle bridges the cuspid

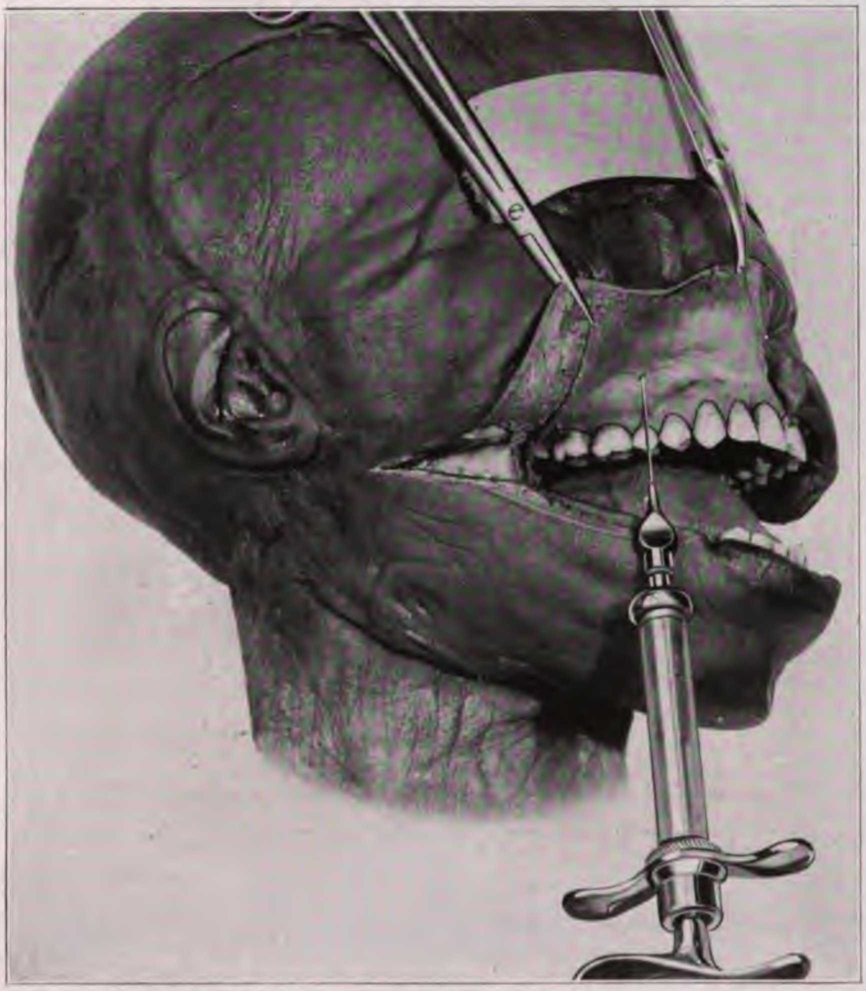


Fig. 303.—Wet anatomical specimen illustrating the starting point of the needle for blocking the anterior superior dental, infraorbital nerve and branches at the infraorbital foramen. Needle is started in the mucous membrane buccal to apex of second bicuspid.

fossa and does not come in contact with the periosteum at any point until it strikes the area near the infraorbital foramen. Fig. 307 shows a lateral view of the needle, and it is noted that there is a considerable distance between the needle and the anterior surface of the superior maxillary bone. In most cases this distance is, at least, 1 cm. between the needle and cuspid fossa. In case any resistance is shown by the patient, it is good practice to inject the solution

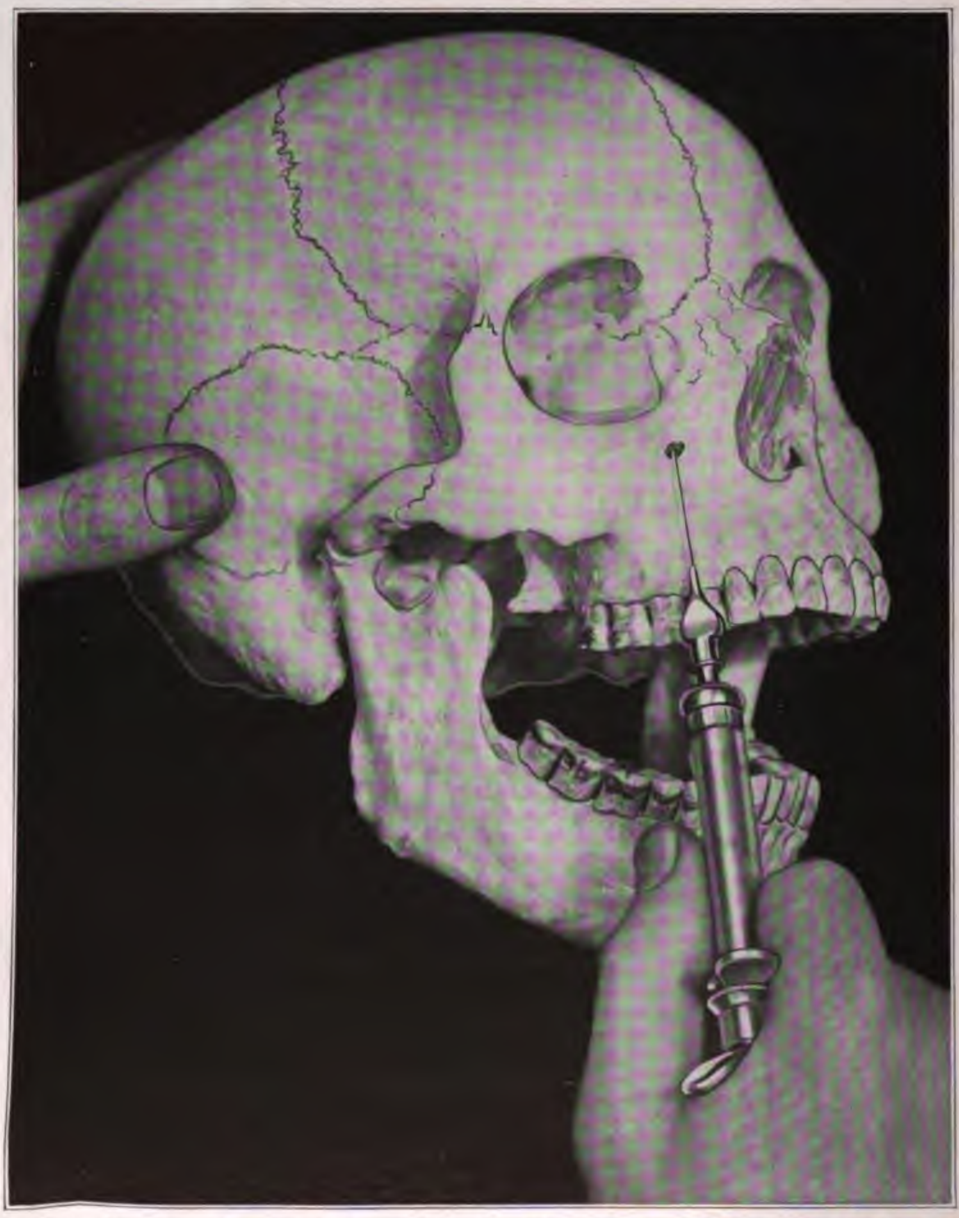


Fig. 304.—Illustrating the needle in region of the infraorbital foramen. Needle is held parallel to long axis of second bicuspid.

from the time the needle enters the tissue until the foramen is reached. A few minims can be discharged while the needle is passing through the tissue, stopping the needle at various intervals and waiting a few seconds before advancing it. However, in nearly every case the infraorbital injection is made without any pain whatsoever.

After two mils of solution are injected at the foramen, the skin around the foramen is massaged in a circular fashion, which will force the solution through the infraorbital canal, thus reaching the anterior superior dental nerve. The part should be massaged for at least one minute, but excessive manipulation should not be practiced as it may cause postoperative soreness, or even produce ecchymosis, especially in a woman who possesses tender skin.

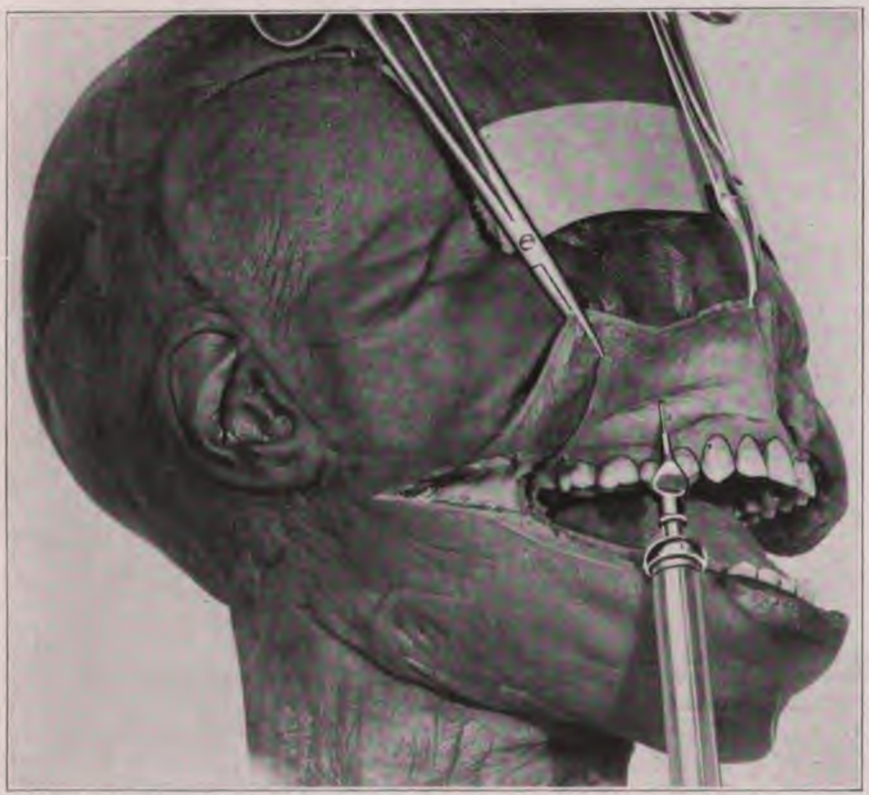


Fig. 305.—Position of the needle while the point is in contact with the periosteum near the infraorbital foramen. Approximately two centimeters of the needle are inserted in the tissue while one centimeter is located exterior to the puncture point.

Injection of Solution.—The amount of solution injected at the infraorbital foramen is two mils. It is advisable to fill the syringe with two and a half mils so as to allow for preliminary injection if needed. With the tip of the index finger placed directly over the infraorbital foramen, the operator will immediately detect the presence of the solution which is being slowly discharged, as it will distend the tissues located exterior to the foramen.

While discharging the solution it is advantageous to manipulate the needle back and forth through a distance of 2 or 3 mm. for the purpose of aiding the solution in leaving the syringe.

Precautions.—Hundreds of operators have informed the author that they have experienced more difficulty in blocking the anterior superior dental than any other nerve branch, except the middle superior dental nerve. The principal reason why so many operators have failed with this injection is that they have attempted to follow the periosteum with the needle and, as a result, the infraorbital foramen has never been reached, and the solution has been injected below the desired location. In other words, the solution was deposited in the floor of the cuspid fossa (see Fig. 313). When the solution is injected in this manner, it matters not how much massaging is done, there will not be enough of the solution to enter the opening of the infraorbital foramen and canal to block the anterior superior dental nerve. The solution will follow the lines of least resistance, and when it is discharged on the anterior surface of the superior maxillary bone and massaging is done, it will infiltrate in all directions, producing an excellent anesthesia of the inferior palpebral, lateronasal and superior labial nerves, which means nothing so far as operative dentistry is concerned, for the reason that these nerves do not supply the teeth or alveolar process. (See Figs. 60, 309, and 312.)

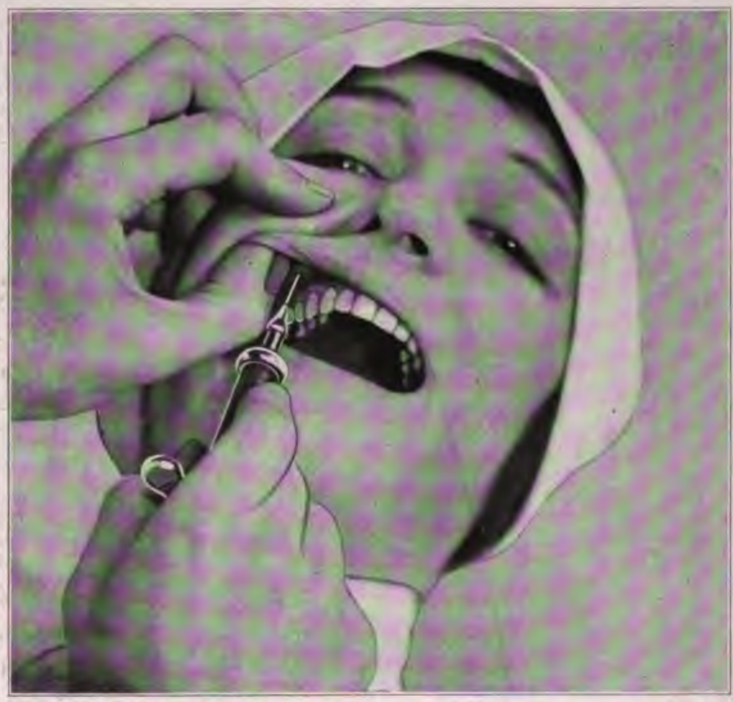


Fig. 306.—Showing position of needle which is parallel to the long axis of the second bicuspid while discharging the solution at the infraorbital foramen. The index finger is resting directly over the foramen while the thumb is raising the lip.

The operator should be very cautious in observing that the point of the needle is located at the opening of the infraorbital foramen before the solution is discharged, and when the solution is discharged at this point and the massaging is correctly done, sufficient solution will pass backward into the infraorbital canal to produce profound anesthesia of the anterior superior dental nerve, which supplies the central, lateral and cuspid teeth and other structures.

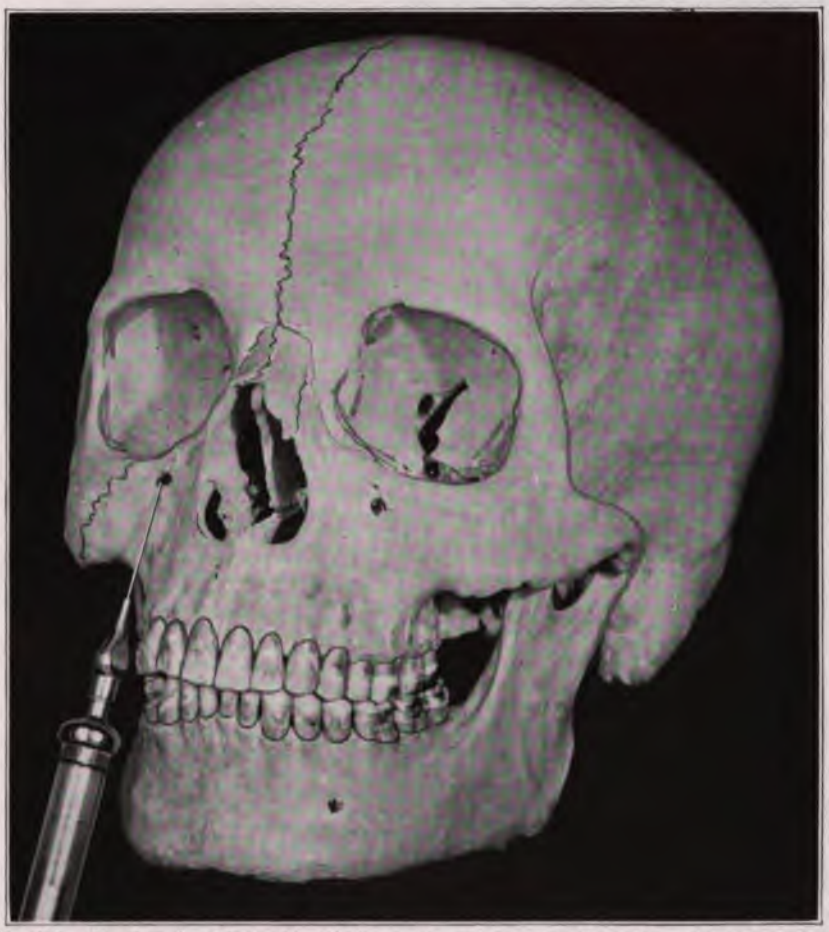


Fig. 307.—Showing the relationship of the needle and the anterior surface of the superior maxillary bone. The needle does not strike the periosteum until the region of the foramen is reached. The needle bridges the cuspid fossa.

Another common mistake which is made by many operators is that of not advancing the needle upward parallel to the long axis of the upper second bicuspid towards the infraorbital foramen. The usual practice is to allow the needle to form an acute angle with the external surface of the superior maxillary bone. (See Fig. 313.) The author desires to place much emphasis upon this particular phase of the technic, inasmuch as it means so much to the successful outcome of the infraorbital injection. Greater care should be exercised in the execution of the technic in the making of the infraorbital and mental injections than any other of the deep block injections, for the important reason that the solution in both of these instances should be deposited at the foramina, and that anesthesia depends upon the injection of the solution directly at the opening of the foramen and the proper massaging.

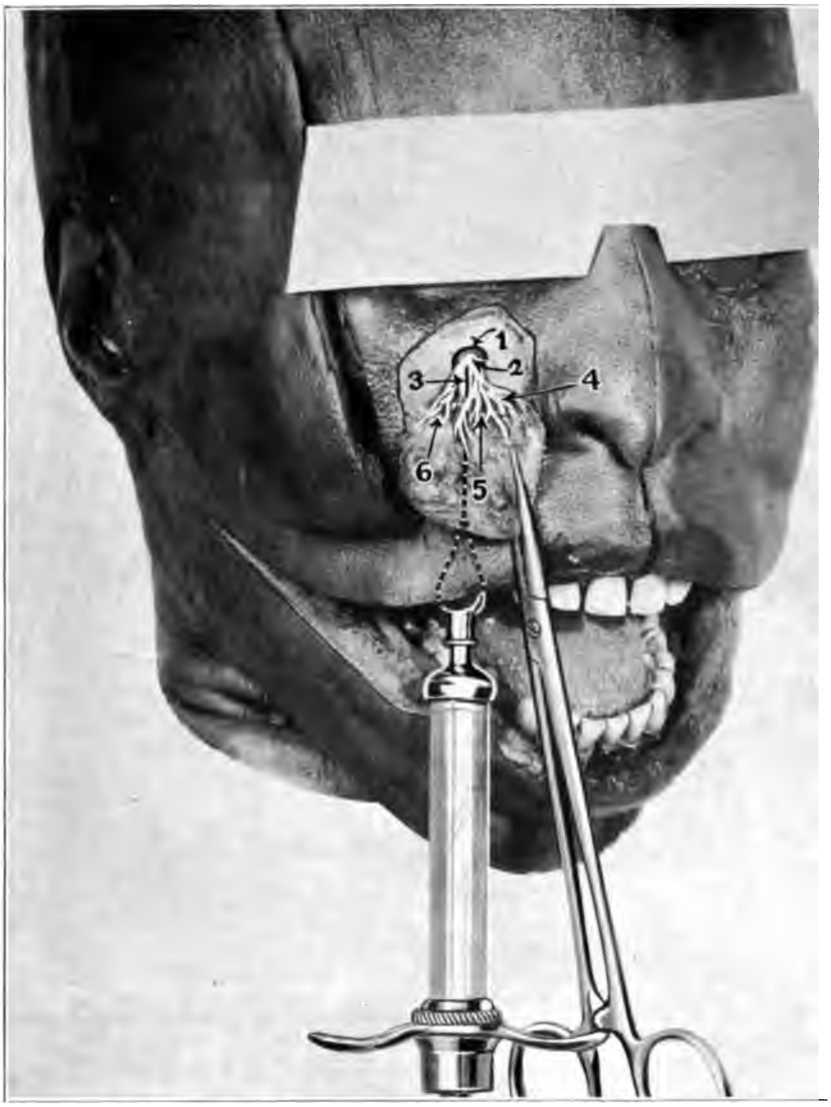


Fig. 308.—Dissected wet anatomical specimen showing the needle (indicated by the dotted line) for injecting the solution at the infraorbital foramen.

1, infraorbital foramen; 2, infraorbital nerve; 3, needle in position at infraorbital foramen; 4, lateral nasal nerve; 5, inferior-palpebral nerve; 6, superior labial nerve.

There is a tendency on the part of many operators to have the chair too low, instead of having it raised a considerable distance, and the patient assuming a semisupine position. It will be found that this position is advantageous to the operator, inasmuch as he can obtain a correct alignment and see exactly what he is doing. Massaging should always be done in a circular manner, that is, massaging around the periphery of the injected solution so as to retain the solution in the immediate region of the foramen as long as possible. If pressure is exerted directly over the solution during the process of massaging, it will cause it to infiltrate in all directions, thereby lessening the amount of solution entering the infraorbital canal. The injec-

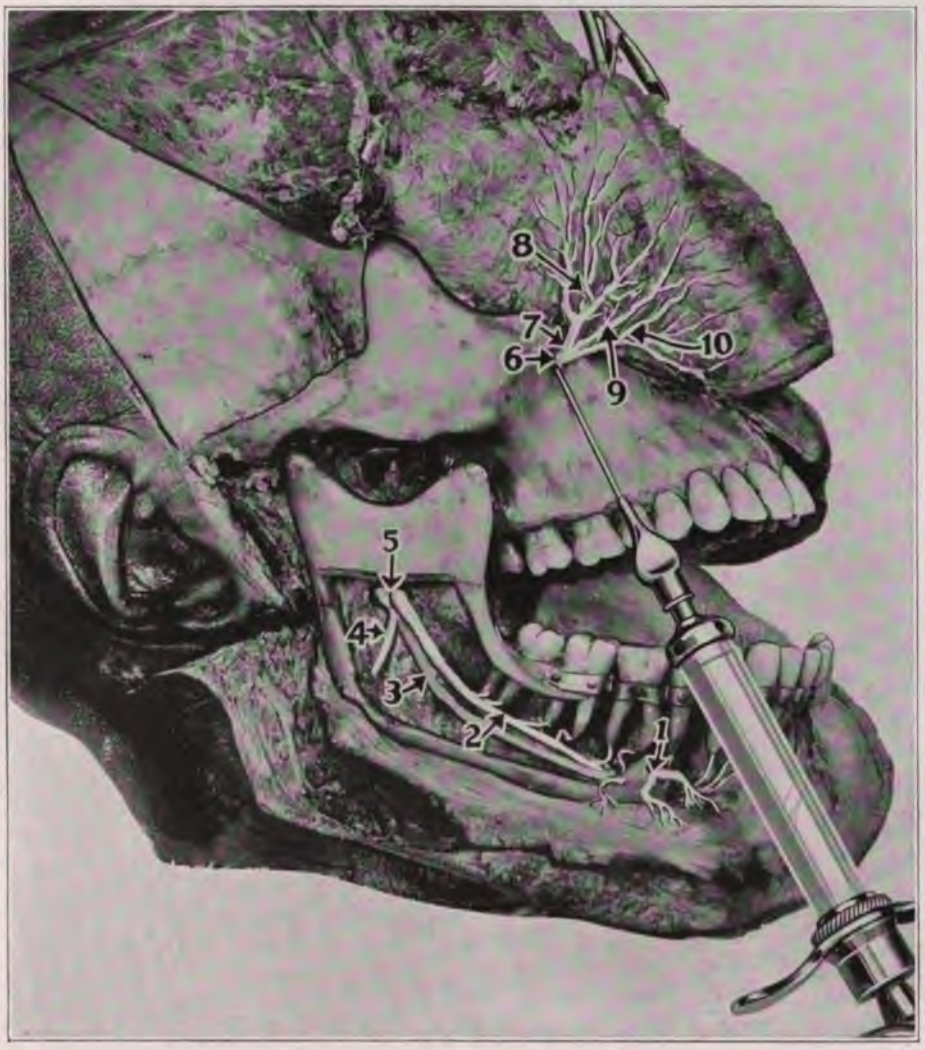


Fig. 309.—Showing the needle for blocking the nerve branches at the infraorbital foramen. It is held parallel to the long axis of the second bicuspid. The needle is in contact with the periosteum in the immediate region of the foramen only.

1, mental nerve and foramen; 2, inferior dental nerve; 3, inferior dental artery; 4, inferior dental vein; 5, region of inferior dental foramen; 6, infraorbital foramen; 7, infraorbital nerve; 8, infrapalpebral nerve; 9, superior labial nerve; 10, lateral nasal nerve.

tion should not be given in case inflammation and infection are present, but instead the second division is blocked by the intraoral method.

Time to Wait for Anesthesia.—The time to wait for anesthesia following the infraorbital injection is from seven to ten minutes. However, the time element is dependent upon the four factors enumerated on page 196. The author has, in many cases, removed teeth within five minutes after the infraorbital injection with complete anesthesia of the tissues. If the solution is not injected at the opening of the infraorbital foramen, a longer time must elapse before deep anesthesia has been secured, for the reason that the solution must pass a greater distance to reach the anterior superior dental nerve. In case the solution has been injected too far from the opening of the infraorbital foramen, even with excessive massage, deep anesthesia will not be secured.

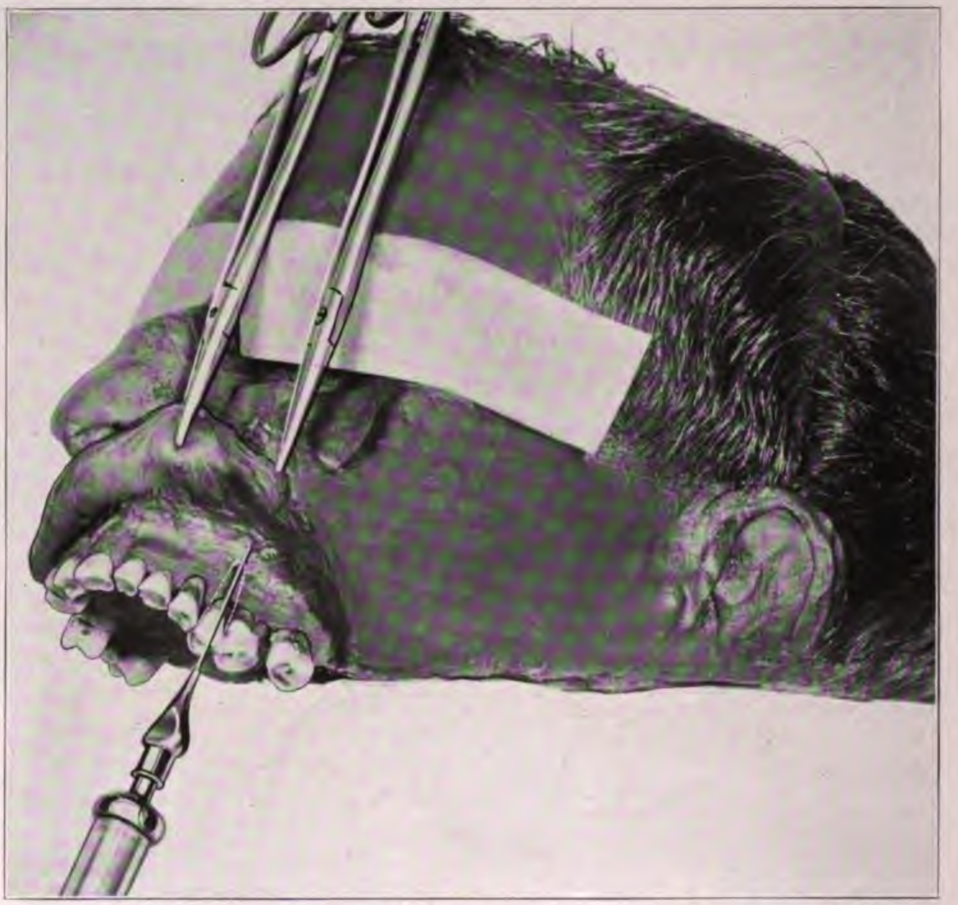


Fig. 310.—Showing first position of needle for making infraorbital injection on left side.

Structures Anesthetized.—The tissues blocked following the infraorbital injection are: a portion of the superior maxillary bone, alveolar process, cuspid, lateral and central incisor teeth, labial periosteum, gum tissue, and labial mucosa (see Figs. 314 and 315). In most cases the lateral incisor is thoroughly anesthetized, but anesthesia of the central and cuspid teeth is only partial, because the interlacing or overlapping branches from the opposite side and from the middle superior dental on the same side are not blocked and must be anesthetized by other injections. In addition to the above-named dental tissues, the inferior palpebral, lateronasal and superior labial branches upon the face are blocked, which anesthetizes the lower eyelid, skin covering the infraorbital margin, skin and cartilage on the side of the nose, and upper lip from the median line to the angle of the mouth.

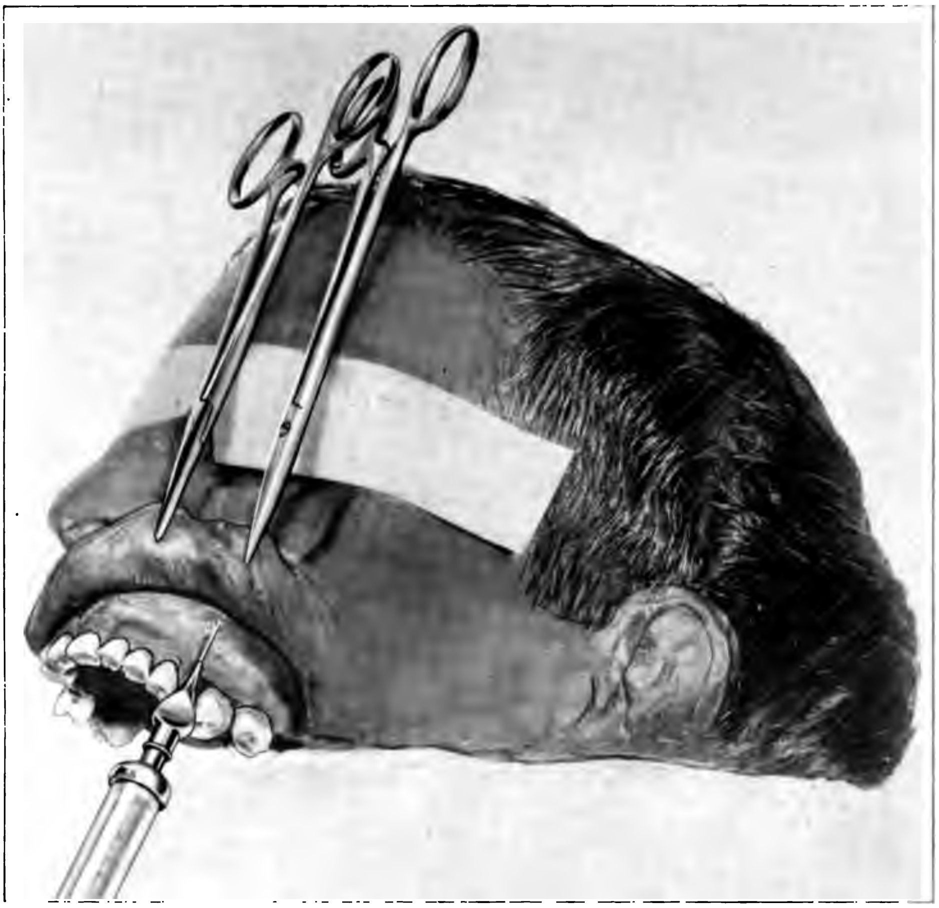


Fig. 311.- Showing needle inserted for making the infraorbital injection on left side. The needle is held parallel to the long axis of the second bicuspid.

In addition to the infraorbital injection, it is necessary to block the overlapping or interlacing branches which will now be considered.

Blocking the Interlacing or Overlapping Branches in the Infraorbital Region. - If the operator is familiar with the nervous anatomy in this region, he will readily appreciate why it is necessary to make additional injections to bring about profound anesthesia in the region occupied by the cuspid, lateral and central incisor teeth. The anterior superior dental nerve communicates with its fellow across the median line and with the middle superior dental on the same side. (See Figs. 40 and 60.) The overlapping or communicating branches can in many instances be blocked by the terminal or infiltration method, which is as follows:

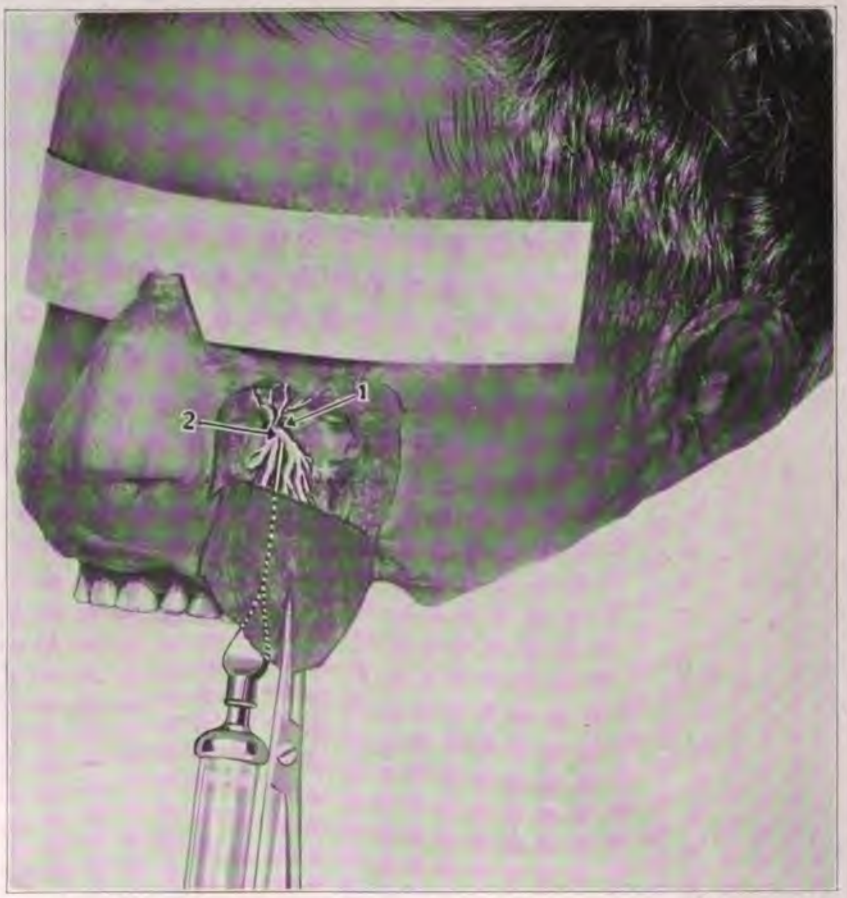


Fig. 312.—Showing needle in position at the infraorbital foramen. Dotted outline indicates the needle in the tissue.

1, infraorbital foramen; 2, needle in position in region of infraorbital foramen for blocking the infraorbital nerve intraorally.

Needle No. 3, 24 gauge, and 15 mm. in length, is employed. Fill the syringe with two mils of the solution. Start the needle in the mucosa above and labially to the apex of the cuspid tooth, holding the needle parallel to the occlusal surface of the bicuspid teeth. (See Fig. 317.) Inject three minims into the mucosa and after waiting fifteen seconds gradually advance the needle downward and beneath the surface of the periosteum, slowly injecting one mil of solution above and to the distal of the apex of the cuspid tooth.

The second injection for blocking the communicating branches is now made, using the same needle, and similar amount of solution. Puncture the mucosa above and to the labial of the apex of the central incisor. The needle is held parallel to the incisal edge of the central incisors. Advance the needle beneath the mucosa and inject three minims of solution. After waiting fifteen seconds, advance the needle downward and beneath the periosteum, across the median line as illustrated in Fig. 320 until it reaches the area above and between the apices of the central incisors, at which point inject one mil of solution. These two injections should be sufficient to block the overlapping branches, provided the external alveolar plate allows the solution to permeate it. If the external alveolar plate is very dense, deep anesthesia may not be secured, and other methods must then be employed.

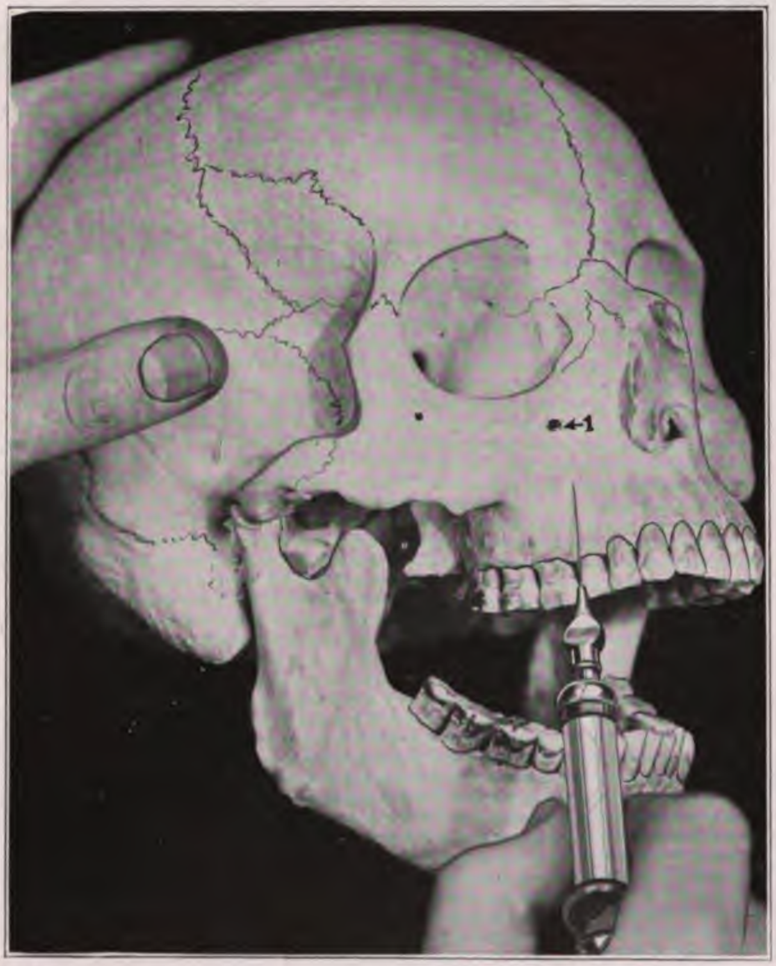


Fig. 313.—The point of the needle in contact with the periosteum in the cuspid fossa. This is what will happen if the operator attempts to advance the needle in contact with the periosteum from the starting point. This is one of the common causes of failure. 1. Infraorbital foramen.

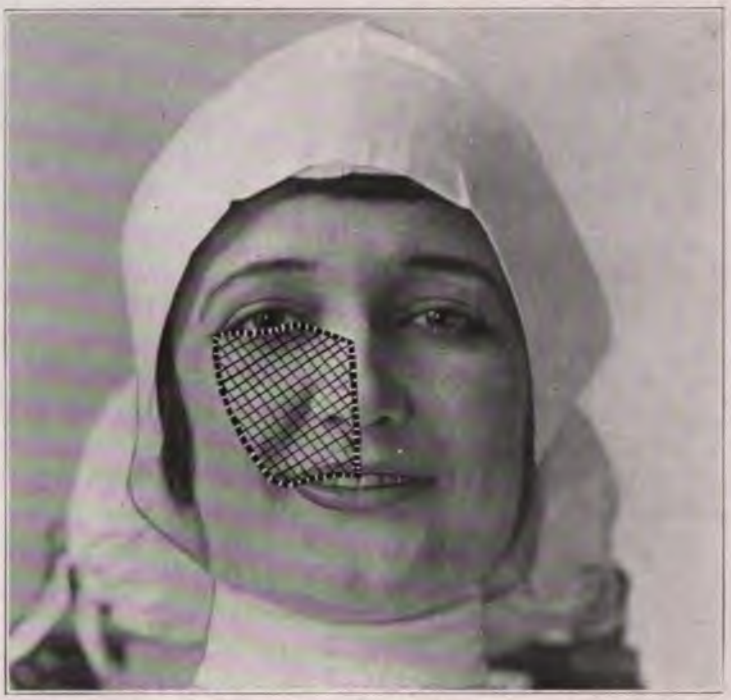


Fig. 314.—Illustrating the area which is blocked following an infraorbital injection.

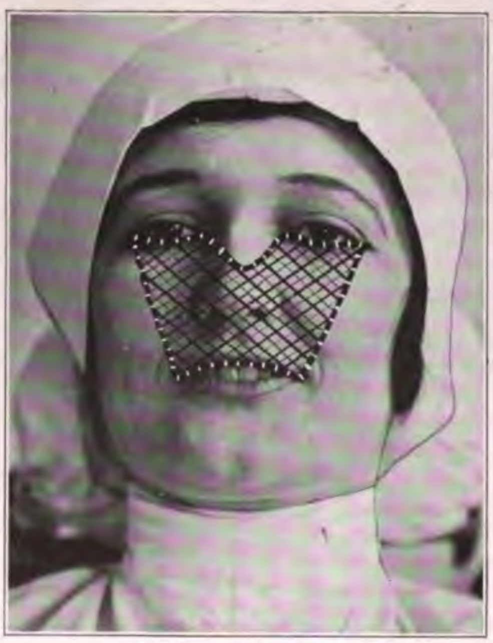


Fig. 315.—Illustrating the area which is blocked following right and left infraorbital injections.

Blocking the Interlacing or Overlapping Branches by the Intraosseous Method.—Another method for blocking the interlacing or overlapping branches existing between the anterior and middle superior dental branches is to make an intraosseous injection on each side, distal and above the apex of the cuspid, using one mil of solution for each injection. When the intraosseous method is employed for this purpose, it is used following the right and left infraorbital injections.

BLOCKING THE ANTERIOR SUPERIOR DENTAL (ALVEOLAR) NERVE BY THE SUBPERIOSTEAL, TERMINAL OR INFILTRATION METHOD

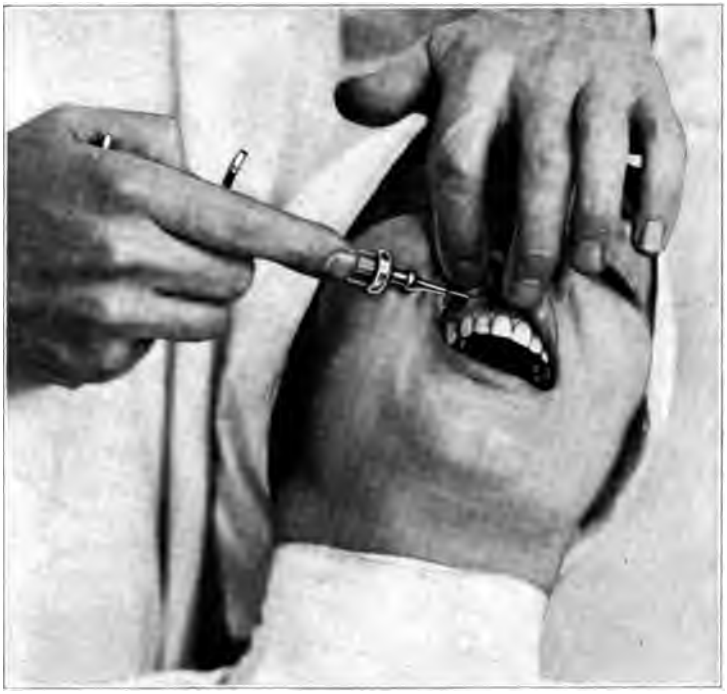


Fig. 316.—Anesthetizing the right central, lateral and cuspid teeth by the subperiosteal infiltration method.

The general principles of injecting the solution by the terminal or infiltration method have been given on page 430 for the blocking of the middle superior dental nerve. The writer has pointed out how the area occupied by the cuspid, lateral and central incisor teeth is blocked by injecting the solution at the infraorbital foramen. The blocking of this zone by the subperiosteal infiltration or terminal method will now be given. The external alveolar plate, which covers the roots of the cuspid, lateral and central incisor teeth, is, in the majority of cases, rather thin, and if the solution is injected by the subperiosteal method, anesthesia of these teeth, alveolar process, and other labial structures can in many cases be accomplished.

Technic of Injection.—The area is thoroughly prepared in accordance with instructions given on page 355. Needle No. 4, 30 mm. in length, 25 gauge, is employed. The syringe is filled with two mils of the injecting solution. The mucosa is punctured labially and distally to the apex of the cuspid tooth, holding the needle parallel to the occlusal plane of the teeth. (See Fig. 316.) Advance the needle into the mucosa, injecting three or four minims of the solution. Now advance the needle gently beneath the periosteum and inject five minims of the solution above the apex of the cuspid tooth. Advance the needle four or five millimeters and again inject five minims of solution, allowing at least one-half minute to elapse before advancing the needle farther into the tissue. Repeat this procedure as often as is necessary until the point of the needle reaches the area to the labial and the mesial of the apex of the central incisor tooth in the region of the median line.

In some cases, the external alveolar plate covering these teeth is very uneven, which is caused by the presence of the roots of the teeth. If the surface of the external plate is of this nature, the operator may have some difficulty in extending the needle beneath the periosteum. If this difficulty arises, the needle should be advanced in contact with the periosteum and the solution injected accordingly. The total quantity of solution injected is 2 mils, and it should be distributed from a point distal to the apex of the cuspid to a point mesial to the apex of the central incisor. By distributing the solution over the labial plate mesially and distally to the operative area, there is greater possibility for the solution to permeate the external alveolar plate, thereby entering the middle cancellous plate and producing anesthesia of the branches of the anterior superior dental nerve as they enter their respective roots of the teeth. (See Fig. 319 which indicates the various points of injection.) The blocking of the overlapping or communicating branches from the anterior superior dental on the opposite side, and from the middle superior dental on the same side of injection, is not necessary, for the reason that the infiltration or terminal injection as given above, will block these branches provided the solution permeates the external alveolar plate.

In case an alveolar abscess or some other form of inflammation is present in the region of injection, this form of local anesthesia is contraindicated, and the operator should then select another method of producing anesthesia. By injecting the solution buccally and distally to the apex of the cuspid tooth, this area can also be blocked by making the right and left infraorbital injections, combined with the blocking of the communicating branches from the middle superior dental by the subperiosteal infiltration method. The inexperienced operator may have the impression that if an alveolar abscess is located in the region of the cuspid, lateral or central incisor teeth, it would be poor practice to make an infraorbital injection. He should not lose sight of the fact that the needle is not inserted into the tissues in the immediate region of the three teeth named above while making the deep infraorbital injection, but it is inserted in the mucosa to the buccal and above the apex of the upper second bicuspid tooth, which is a considerable distance from the infected area.

BLOCKING THE UPPER CUSPID BY THE SUBPERIOSTEAL, INFILTRATION OR TERMINAL METHOD

Needle No. 3, 24 gauge, 15 mm. in length, is employed. The syringe is filled with two mils of solution. The mucosa is punctured by the needle to the labial and above the apex of the root of the cuspid, holding the needle parallel to the occlusal plane of the bicuspid teeth. (See Fig. 317.) The needle is advanced gently downward into the mucous membrane, and four minims of the solution are injected, and after waiting for one-half minute the needle is advanced beneath the periosteum and four more minims of the solution are injected. After one-half minute the needle is directed backward beneath the periosteum 5 mm. and five minims of solution are again injected. This process is repeated until the point of the needle reaches the area above and to the labial of the apex of the first bicuspid tooth. (See Fig. 319.) The needle is now carefully retracted, but is not removed from the tissue. The needle must be removed from beneath the periosteum, but is allowed to remain in the mucosa. The syringe is now carried to the opposite side, and the needle is directed towards the median line. (See Fig. 318.) Now repeat the technic as given above. Advance the needle medially beneath the periosteum covering the anterior labial plate until the needle

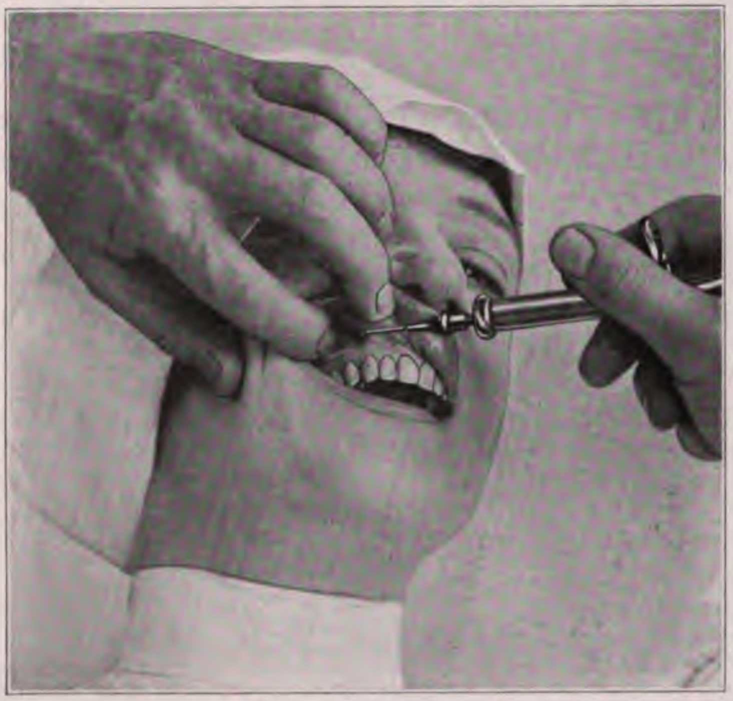


Fig. 317.—Needle entering the mucosa labial to apex of cuspid and advancing distally to anesthetize the cuspid and additional teeth by the subperiosteal method.

point reaches an area to the labial and above the apex of the lateral incisor. The total quantity of solution injected is two mils, that is, to the distal, labial and mesial of the apex of the cuspid. Only one puncture has been made in the mucous membrane, and the cuspid tooth has been used as the dividing line between the two injections. The object for starting the needle above and to the labial of the cuspid tooth and using two positions of the syringe, as above illustrated, is because of the prominent cuspid eminence. When the needle is inserted, as directed above, it can easily be forced backward and medially beneath the periosteum, which would be absolutely impossible if the needle was started anterior to the cuspid eminence or posterior to it, and then the endeavor made to force the needle around the curvature of bone. If the density of the external alveolar plate allows the solution to permeate it, this injection will produce anesthesia for pulp removal, cavity preparation, shaping of the crown for an artificial appliance, etc. If the lingual gum tissue and periosteum are involved in the operation, it is then necessary to block the terminal branches of both the nasopalatine and anterior palatine nerves which overlap lingually to the apex of the cuspid. (See page 511 for technic.)

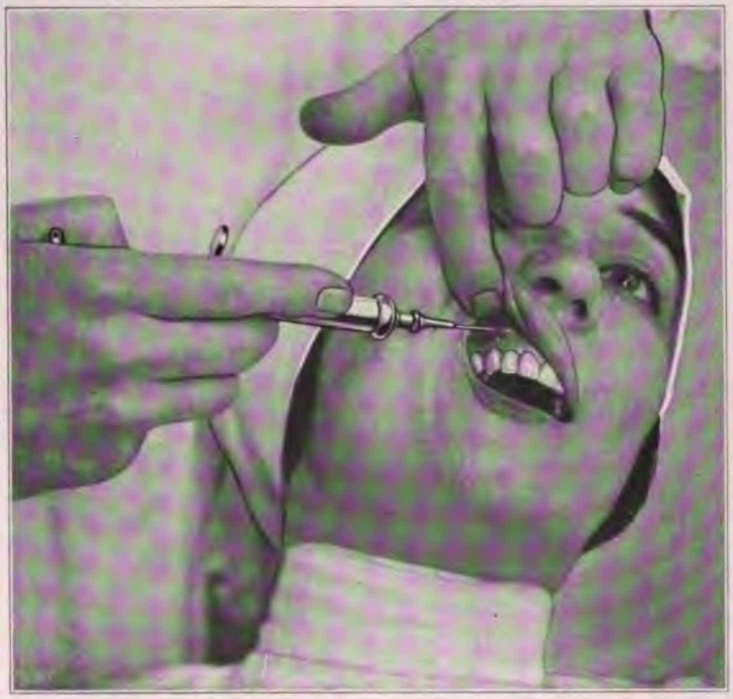


Fig. 318.—Needle entering mucosa labial to apex of cuspid and advancing mesially to anesthetize the cuspid and additional teeth by the subperiosteal method.

BLOCKING THE UPPER LATERAL INCISOR BY THE TERMINAL OR INFILTRATION METHOD

Blocking the lateral incisor by the terminal or infiltration method is accomplished in the following manner: The needle used is No. 3, 15 mm. in length, 24 gauge. The amount of solution injected is one and a half mils. The mucosa is punctured to the labial and above the apex of the cuspid tooth. (See Fig. 318.) After the needle enters the mucosa, five minims of solution are injected, and after one-half minute is allowed to elapse, the point of the needle is advanced beneath the periosteum, and five minims of the solution slowly injected. After one-half minute, advance the needle four or five millimeters mesially beneath the periosteum covering the labial alveolar plate. Repeat this technic until the needle point is situated above the apex of the central incisor. By this technic the solution is injected mesially, labially, and distally to the area of the lateral incisor. This injection should be sufficient for cavity preparation, pulp removal, or other operations upon the teeth or labial structures. Numbers 6, 7, 8, and 9 in Fig. 319 illustrate the various points of injection for blocking the lateral incisor tooth. If the lingual tissues are involved in the operation, such as for extraction, then the nasopalatine branch on the lingual side must be blocked. (See page 518 for technic.)

BLOCKING THE UPPER CENTRAL INCISOR BY THE SUBPERIOSTEAL, TERMINAL OR INFILTRATION METHOD

If it is the desire of the operator to block only one central incisor by the subperiosteal, terminal or infiltration method, the following technic is employed:

The needle employed is No. 3, 15 mm. in length and 24 gauge (see Fig. 177). One and a half mils of the solution are injected. The mucosa is punctured to the labial and above the apex of the lateral incisor. The needle is advanced into the mucosa in the same manner as heretofore described, and five minims of the solution are slowly injected. One-half minute should elapse before advancing the needle beneath the periosteum, and again slowly injecting five minims of the solution. This process is repeated as often as necessary until the needle point passes across the median line. In case the nasal spine which is formed by the superior maxillary bones is prominent at the articulation, it may interfere with extending the needle across the median line. If the point of the needle should encounter an obstruction, the remaining solution is injected at the median line near the articulation without forcing the needle anteriorly to this bony prominence. The operator will observe that the solution is injected to the labial, mesial, and distal of the central incisor region. One and a half mils are usually injected. While advancing the needle beneath the periosteum it should be held parallel to the incisal edges of the central incisors. This injection should be sufficient for dental operations on the central incisor, and labial structures. If the tooth is to be extracted, or the lingual gum tissue and periosteum are involved, then the nasopalatine nerve on the lingual side must be blocked. (See page 518 for technic.)

BLOCKING THE UPPER CUSPID, LATERAL AND FIRST BICUSPID TEETH BY THE SUBPERIOSTEAL, TERMINAL OR INFILTRATION METHOD

The blocking of these three teeth by the terminal or infiltration method is accomplished as follows:

The needle employed is No. 4, 30 mm. long, and 25 gauge. The syringe is filled with 2 mils of the solution. The mucosa is punctured to the labial and above the apex of the cuspid tooth. (See Figs. 317 and 319.) Advance the needle into the mucosa and inject 5 minims of solution, and after waiting one-half minute, advance the needle beneath the periosteum, and then slowly inject 5 more minims of solution. The needle is extended backward parallel to the occlusal plane of the bicuspid teeth, injecting the solution every time the needle is advanced 4 or 5 mm. This procedure should be repeated until the point of the needle is over the apex of the second bicuspid tooth (see Fig. 319). Retract the needle and make sure it is released from beneath the periosteum; now extend the syringe to the opposite side (see Figs. 318 and 319), and force the needle mesially, using the same technic as given above until the needle point is over the apex of the central incisor on the same side of injection. The cuspid is used as a dividing line, and only one puncture is made. The entire quantity of solution injected is two mils, using one mil for each position of the syringe, that is, to the distal and mesial of the cuspid. If the external alveolar plate is porous and the solution infiltrates through it, anesthesia of the cuspid, lateral and first bicuspid teeth will be secured. Dental operations can be performed upon these teeth and labial tissues. If the teeth are to be extracted and the tissues on the lingual side are to be involved in the operation, then the branches of the nasopalatine nerve are blocked by injecting the solution to the lingual of the apex of the lateral incisor (see page 518 for technic), and the anterior palatine nerve is blocked by injecting the solution to the lingual of the apex of the upper first bicuspid. (See page 509 for complete technic.)

BLOCKING THE CENTRAL, LATERAL, CUSPID, FIRST AND SECOND BICUSPID TEETH BY THE TERMINAL OR INFILTRATION METHOD

The blocking of these five teeth by the subperiosteal, terminal or infiltration method is accomplished by one insertion of the needle. Needle No. 4 is employed. The mucosa is punctured above and labial to the apex of the cuspid tooth. (See Figs. 317 and 319.) The needle is carried backward and the solution is injected identically in the same manner as is given above until the point of the needle reaches an area distal and above the apex of the second bicuspid root. The needle is retracted and the syringe is extended to the opposite side and the needle is advanced along the labial alveolar plate beneath the periosteum until the median line is reached. (See Figs. 318 and 319.) Caution should be exercised to keep the needle in contact with the external alveolar plate and beneath the periosteum while the solution is being injected; also to observe that the needle is held parallel to the occlusal plane of the bicuspid teeth while making the injection. Three mils of solution are equally divided in the two regions of injection.

This injection is sufficient for dental operations upon the teeth, alveolar process and other labial structures, but in case the lingual gum tissue or periosteum is involved in the operation, as for extraction, then the nasopalatine nerve should be blocked at the anterior palatine foramen (see page 512 for technic), and the anterior palatine nerve should be blocked lingual to the apex of the second bicuspid tooth. (See page 509 for technic.)

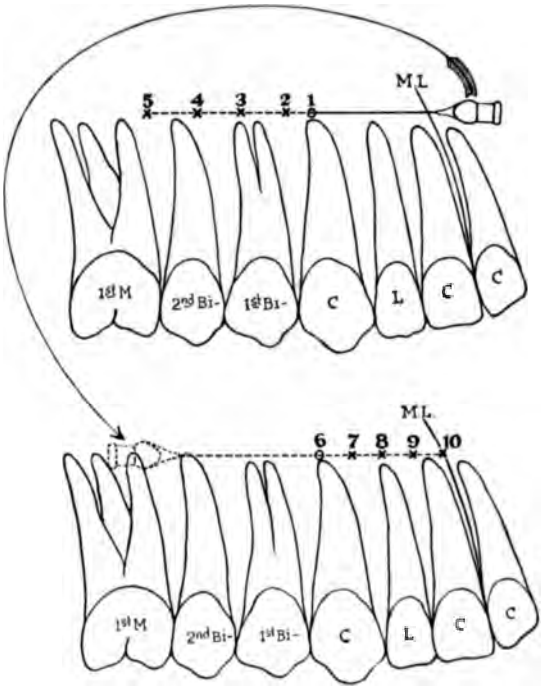


Fig. 319.—Diagram illustrating the manipulation of the needle for anesthetizing the central, lateral, cuspid, first and second bicuspid teeth.

M.L. represents median line; No. 1, starting point of needle in tissue labial to apex of cuspid tooth; dotted line represents passage of needle beneath the periosteum. Each x represented by Nos. 2, 3, 4, 5 shows the various points for discharging 5 minims of solution. The arrow represents how the needle is turned in order to inject the solution at the various points indicated by 6, 7, 8, 9, and 10.

BLOCKING THE TWO UPPER CENTRAL INCISORS BY THE SUBPERIOSTEAL, TERMINAL OR INFILTRATION METHOD

The syringe is filled with two mils of solution. Needle No. 3 is employed. The mucosa is punctured above and between the apices of the central incisors at the side of the frenum, and five minims of solution are slowly injected. The syringe is held parallel to the incisal angle of the teeth and the needle is advanced laterally beneath the periosteum, and five minims of solution are slowly injected. The needle is forced distally beneath the periosteum until it reaches the apex of the lateral incisor (see Fig. 320). The needle is now retracted, making sure that it is from beneath the periosteum and similar technic is employed on the opposite side, which requires advancing the needle through the frenum and the median line. One-half mil of solution is injected on either side. (See Fig. 321.) This injection is sufficient, if the solution permeates the labial plate, for operative dentistry on the central incisor teeth; but if the teeth are to be extracted, then the lingual gum tissue and periosteum must be anesthetized by injecting the solution near the anterior palatine foramen which blocks the nasopalatine nerves. (See page 512 for technic.)

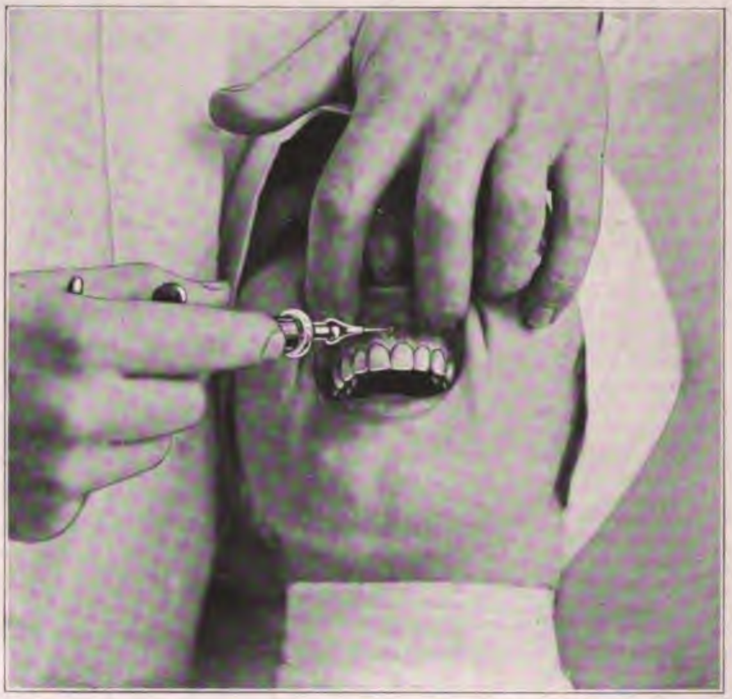


Fig. 320.—Starting the needle at the median line for anesthetizing the centrals and additional teeth, if necessary, by the subperiosteal method.

BLOCKING THE FOUR UPPER INCISOR TEETH BY THE SUBPERIOSTEAL, TERMINAL OR INFILTRATION METHOD

Needle No. 4 is employed. The mucous membrane is punctured at the median line above and between the apices of the central incisors at the side of the frenum (see Fig. 320). The needle is advanced laterally beneath the periosteum, and the solution injected at intervals as given above for blocking other teeth in this region. After the solution is injected on one side, the needle is retracted, and similar technic is employed on the opposite side. (See Fig. 321.) The total quantity of solution injected is two mils. This injection should produce anesthesia for operations upon the teeth and labial structures. Where the teeth are to be extracted or the lingual gum tissue and periosteum are involved, then the nasopalatine nerves are blocked as they emerge from the anterior palatine foramen. (See page 512 for technic.)

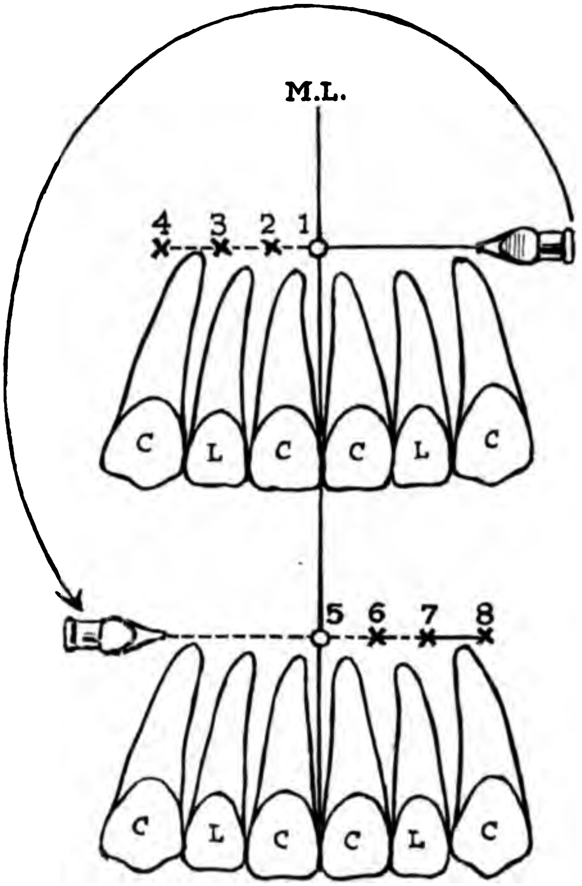


Fig. 321.—Diagram which illustrates the various movements of the needle for anesthetizing the upper six anterior teeth by the subperiosteal infiltration method.

M.L. Median line at which point the needle is started, which is represented by circles and indicated by 1 and 5. No. 2, 3, and 4 represent points of injection. Five minims of solution are injected at points indicated by x. The needle is now carried across the median line as indicated by the arrow and the needle is advanced beneath the periosteum on the left side and solution is injected at each x as indicated by Nos. 5, 6, 7 and 8.

BLOCKING THE UPPER SIX ANTERIOR TEETH BY THE SUBPERIOSTEAL, TERMINAL OR INFILTRATION METHOD

Needle No. 4 is employed and the total quantity of solution injected is three mils. The mucosa is punctured at the side of the frenum above and between the apices of the central incisors (see Figs. 322 and 323) and the needle is extended distally as illustrated in Fig. 324. The solution is injected at various intervals, as explained above, for other injections in this region (see Fig. 321). The needle is advanced laterally beneath the periosteum until it reaches a point to the labial of the apex of the cuspid tooth. The needle is now retracted, the syringe changed to the opposite side, and a similar technic is employed (see Figs. 322, 325 and 326). Only one puncture of the mucosa by the needle, so far, has been made. Next insert the needle over the apex of the cuspid on right and left sides. (See Fig. 317.) Advance the needle backward beneath the periosteum and inject one-half mil of solution distally to the apex of the cuspids on both sides of the arch. Total amount of solution required for the three injections is four mils. (See Figs. 319 and 321.) These injections should be sufficient for operations upon the teeth, alveolar process or other labial structures. If the lingual gum tissue and

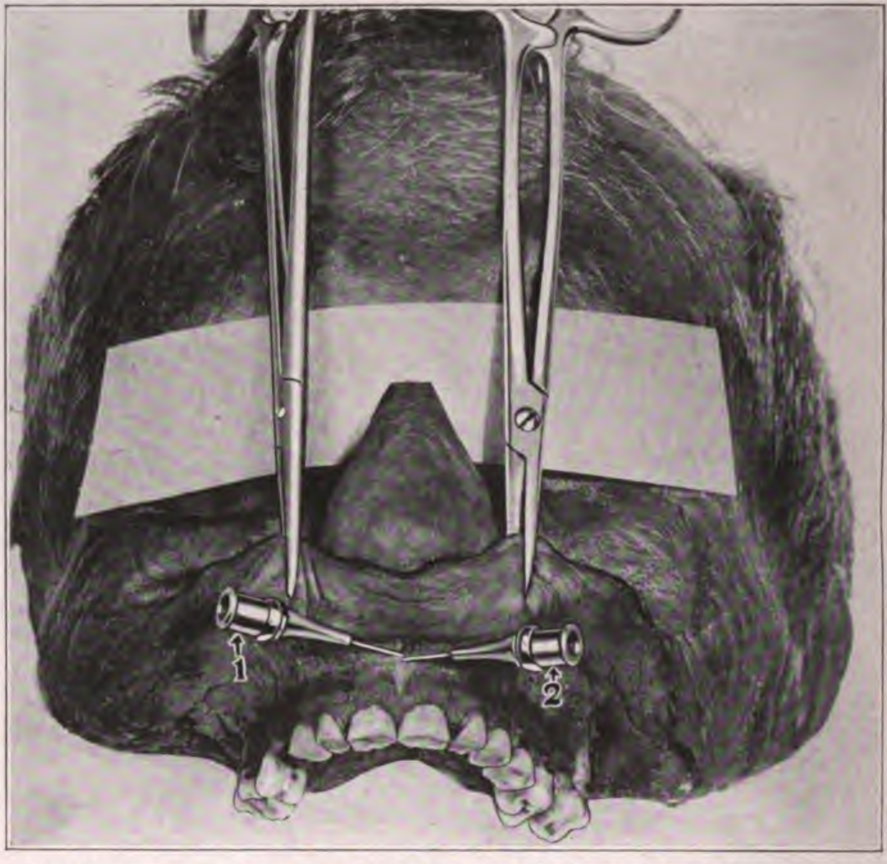


Fig. 322.—Wet specimen illustrating the position of needle for anesthetizing the upper six anterior teeth by the subperiosteal infiltration method. The needle marked No. 1 is held parallel to incisal edge of central, lateral and cuspid on left side and after the solution is injected as shown in Fig. 321 the needle is retracted and turned to the opposite side and advanced in the tissue as shown by No. 2.

periosteum are involved such as for extraction, then three lingual injections must be made, which are as follows:

1. Inject one-half mil of solution at the anterior palatine foramen to block the right and left nasopalatine nerves. (For technic, see page 512.)

2. Block the terminal branches of the anterior palatine nerve by injecting one-half mil of solution to the lingual of the apex of the cuspid tooth. (For technic, see page 511.)

3. Repeat the last named injection on the opposite side, as the terminal branches of both the right and left anterior palatine nerves must be blocked.

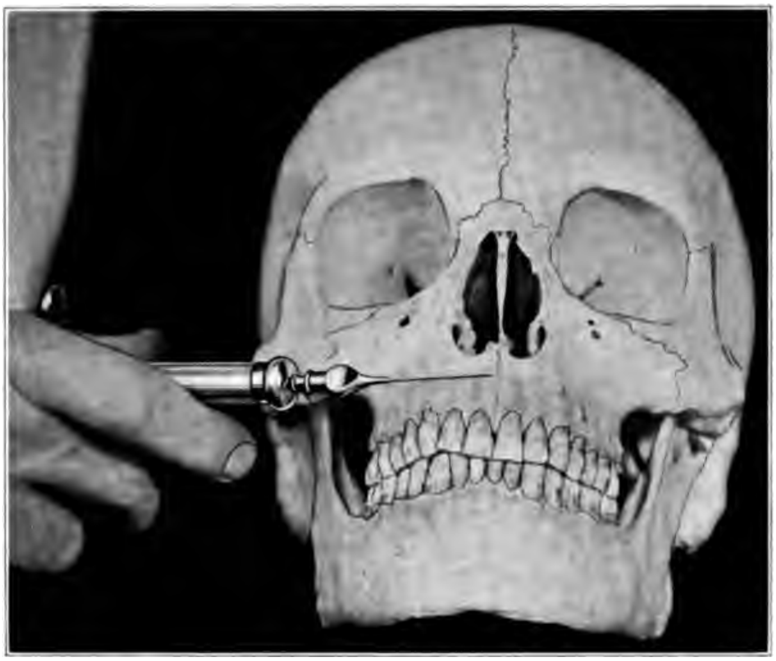


Fig. 323.—Starting point of the needle which is at the median line for anesthetizing the upper left central, lateral and cuspid by the subperiosteal method.

BLOCKING THE UPPER CUSPID, LATERAL AND CENTRAL INCISOR TEETH BY THE INTRAOSSEOUS METHOD

The anterior superior dental nerve, which supplies the central, lateral and cuspid teeth, the alveolar process and labial structures in this region, can be easily blocked by the intraosseous method. The same general technic applies here as that given for blocking the middle superior dental which supplies the two upper bicuspids and first molar teeth. (See page 441.) For blocking the zone supplied by the anterior superior dental nerve, the intraosseous injection is made slightly above and between the apices of the cuspid and lateral incisor teeth. Fig. 330 shows the location of injection. One mil of the solution is injected. Anesthesia is quickly secured in the three above-named teeth, alveolar process, labial periosteum, gum tissue, and mucosa. In some cases profound anesthesia may extend as far laterally as the first bicuspid on the side of injection and the central incisor on the opposite side of the median line. Dental operations, such as pulp removal, shaping the crowns of teeth for abutments, cavity preparation, or operations upon the labial tissues can be performed, but if the teeth are to be extracted, or a granuloma is to be removed, then the nasopalatine nerve and the overlapping branches from the anterior palatine nerve are blocked on the lingual side. The nasopalatine nerve is blocked as it emerges from the anterior palatine foramen (see page 512 for technic) and the overlapping branches from the anterior palatine nerve are blocked lingually to the apex of the cuspid tooth. (See page 511 for technic.)

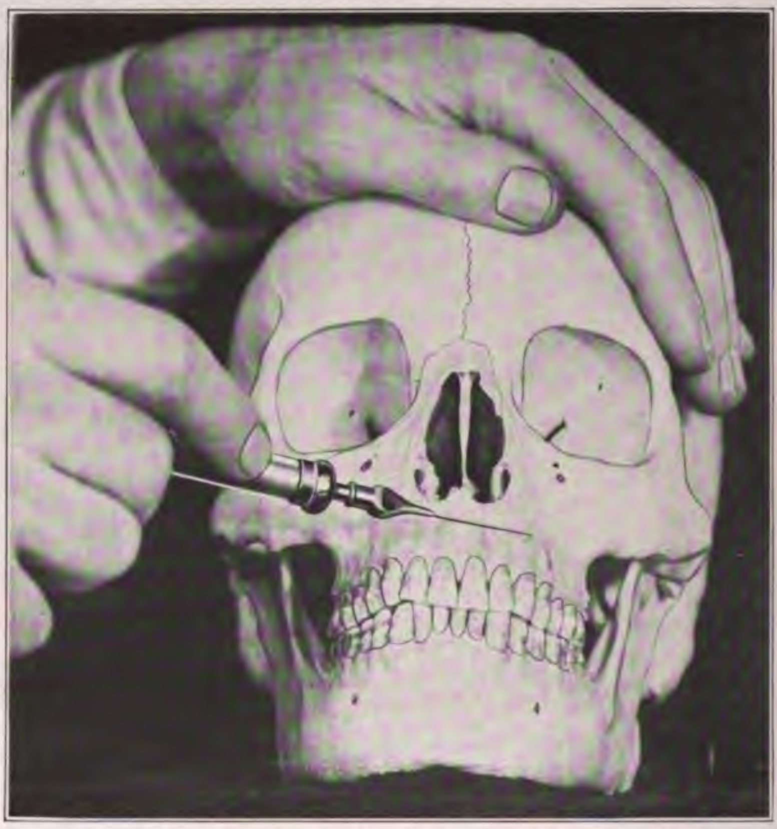


Fig. 324.—Showing needle in position for anesthetizing the upper left central, lateral and cuspid teeth by the subperiosteal method. Needle is held parallel to incisal edge of teeth.

BLOCKING THE UPPER SIX ANTERIOR TEETH BY THE INTRAOSSEOUS METHOD

The blocking of the upper centrals, laterals, and cuspid teeth for operative dentistry is in most cases easily accompanied by a single intraosseous injection. The same general principles given on page 441 apply equally well here.

The injection is made at the side of the frenum near the median line above and between the apices of the central incisor teeth. (See Figs. 327, 328, and 329.) It must be remembered that the nasal spine which is formed by the articulation of the superior maxillary bones, also the frenum, is situated in the median line. It is not advisable to make the intraosseous injection through the nasal spine because it would be difficult to hold the template or guide in position and make the opening with the drill through the external plate. Another important factor is that the bone at the suture is so dense it may prevent the solution from entering the cancellous bone located on either side of the median line, in order to produce anesthesia of the desired area. Therefore, the guide should be placed at the side of the frenum and nasal spine, as illustrated in Figs. 328 and 329; then hold the guide at such an angle that the drill will pierce the external alveolar plate at a point situated between the suture and the apex of the central incisor. The amount of solution injected is two mils. In most cases, one injection is all that is necessary for operations upon the centrals, laterals and cuspids, and labial structures, but if the teeth are to be extracted, then three lingual injections should be made as follows:

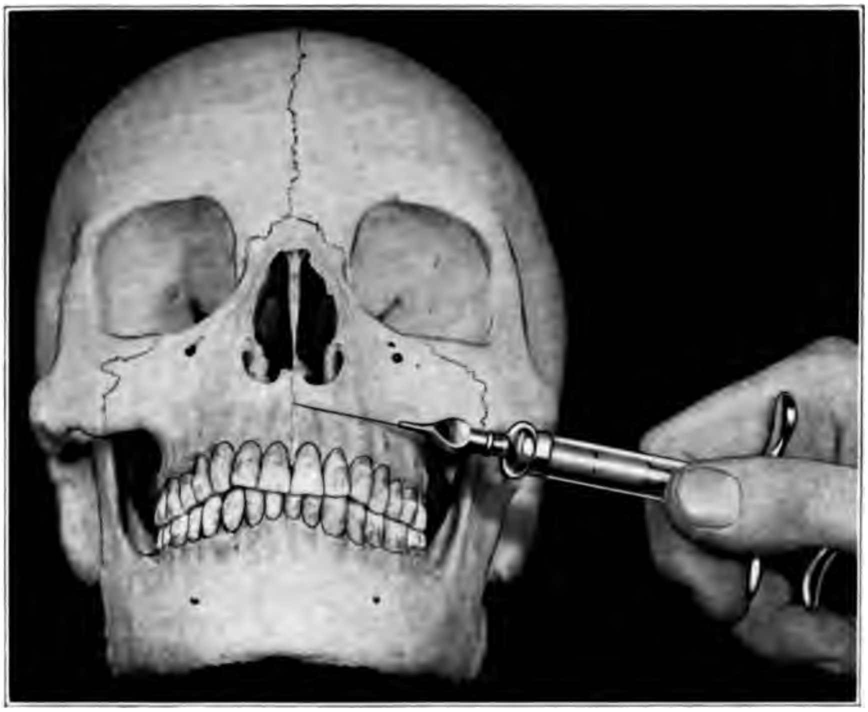


Fig. 325.—Starting point of the needle which is at the median line for anesthetizing the upper right central, lateral and cuspid by the subperiosteal method.

1. Block the nasopalatine nerves as they emerge from the anterior palatine foramen. (See technic, page 512.)

2 and 3. Block the overlapping branches from the anterior palatine lingually to the apex of the cuspid on both sides. (See page 511 for technic.)

If anesthesia of the six teeth can not be secured by one intraosseous injection, then make two injections as given below.

BLOCKING THE SIX UPPER ANTERIOR TEETH BY TWO INTRAOSSEOUS INJECTIONS

The technic, as previously set forth, is for the blocking of the six upper anterior teeth by one intraosseous injection, which is made at the side of the frenum and the nasal spine formed by the articulation of the two superior maxillary bones. In some cases, it is not possible to block these six teeth by a single intraosseous injection because the bone at the suture may be so dense as to interfere with the passage of the solution in the middle cancellous process. In case the operator fails to secure deep anesthesia of the upper six teeth following the use of one intraosseous injection, then two intraosseous injections are given. However, it is seldom necessary to make two separate injections.

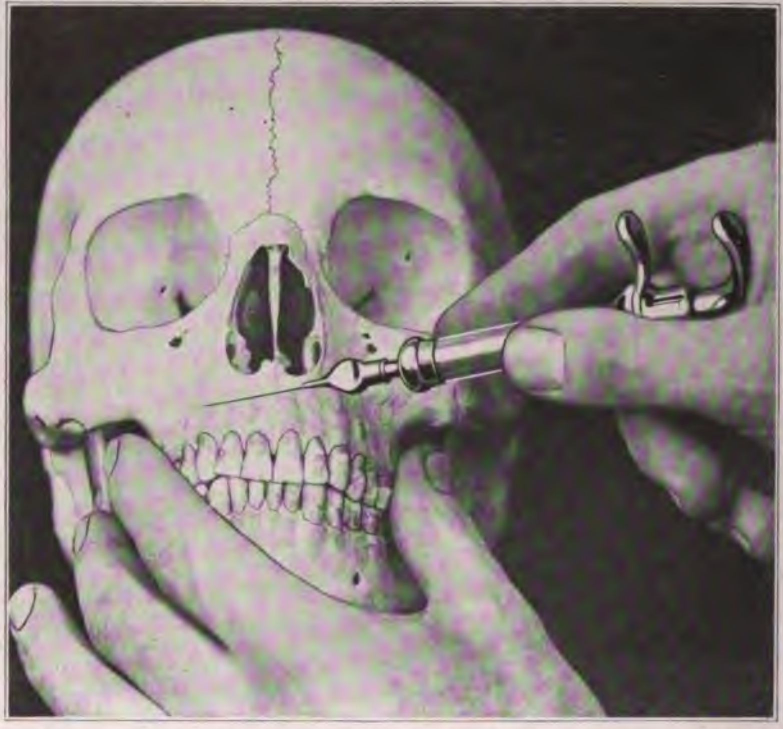


Fig. 326.—Showing needle in position for anesthetizing the upper right central, lateral and cuspid teeth by the subperiosteal method. Needle is held parallel to incisal edge of teeth.

The technic is as follows: The same general principles are employed here as those which have been previously outlined for the blocking of other areas by the intraosseous method. Two injections are made, one on either side of the median line. Each injection is made to the distal and labial of the apex of the lateral incisor. (See Fig. 330.) One mil of solution is employed for each injection. Anesthesia will be secured in the six anterior teeth, alveolar process, and labial structures, which is sufficient for operative dentistry and other operations which involve the labial tissues. If the teeth are to be extracted, then anesthetize the lingual tissues as follows:

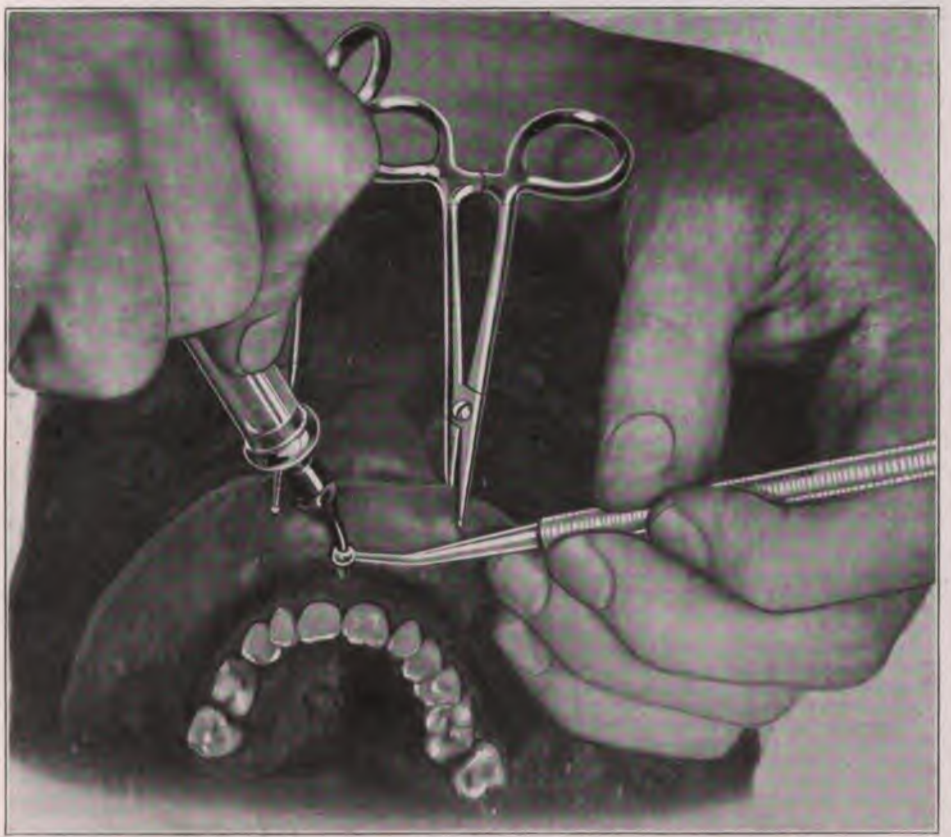


Fig. 327.—Position of intraosseous injection for blocking the upper six anterior teeth. The guide is located just lateral to the nasal spine formed by the articulation of the superior maxillary bones.

1. Block the nasopalatine nerves at the anterior palatine foramen. (See page 512 for technic.)

2. Block the terminal branches of the anterior palatine nerve lingually to apex of the cuspid tooth on the right and left sides of the arch. (See page 511 for technic.)

If the two intraosseous injections have been properly made on both sides, it will not be necessary to inject distally to the cuspid teeth on the labial side because the solution blocks the communicating nerve branches.

EXTRAORAL METHOD OF BLOCKING THE ANTERIOR SUPERIOR DENTAL; INFRAORBITAL NERVE AND ITS TERMINAL BRANCHES

Topography of Anatomy.—The anatomy of the nerves and other tissues which are involved by injecting the solution at the infraorbital foramen has already been discussed in detail in Chapter VII, also under the intraoral method (page 459), and the reader is referred to that part of the text.

Needles Employed.—Two needles are employed: needle No. 4, 30 mm. in length, 25 gauge, for injecting the solution at the opening of the infraorbital foramen by the extraoral route.

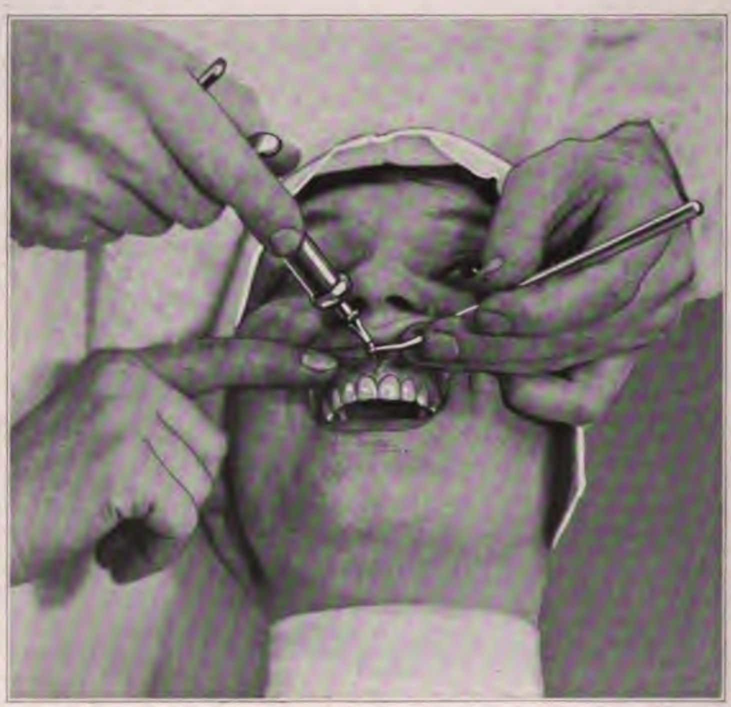


Fig. 328.—Injecting the solution by the intraosseous method for blocking the upper six anterior teeth. The location is between the apex of the central incisor and median line.

Preliminary Injection.—Needle No. 7, 10 mm. in length, 27 gauge, is employed for the initial injection. This is a very fine, sharp needle, and is used for injecting a few minims of solution into the skin to eliminate all pain while inserting the regular block needle to inject the solution at the opening of the foramen.

Technic of Injection.—The skin is prepared over the infraorbital foramen by using 1/1000 solution of bichlorid of mercury, or one per cent lysol or tincture of iodin. After applying an efficient germicide, grasp the skin between the index finger and thumb situated below and over the infraorbital foramen (see Fig. 331). Hold the preliminary needle at an acute angle to the surface of the skin and force the needle point beneath the surface and inject two minims, after which 30 seconds should elapse to allow the solution to act. Now advance the needle into the skin by a gentle rotating movement and inject two more minims of solution. Repeat this procedure until one-half mil of solution has been injected.

The object of making the preliminary injection is to eliminate the pain which is caused by the regular block needle. Three minutes should elapse following the preliminary injection before passing needle No. 4 through the skin into the region of the infraorbital foramen. The puncture of the skin is made 1 cm. below the infraorbital foramen and the needle is directed upward and backward, as illustrated in Fig. 332. When the needle has been advanced approximately one centimeter, the opening of the infraorbital foramen will be reached. (See Figs. 333 and 334.) Before inserting the needle, palpate the infraorbital margin and locate the foramen which is situated

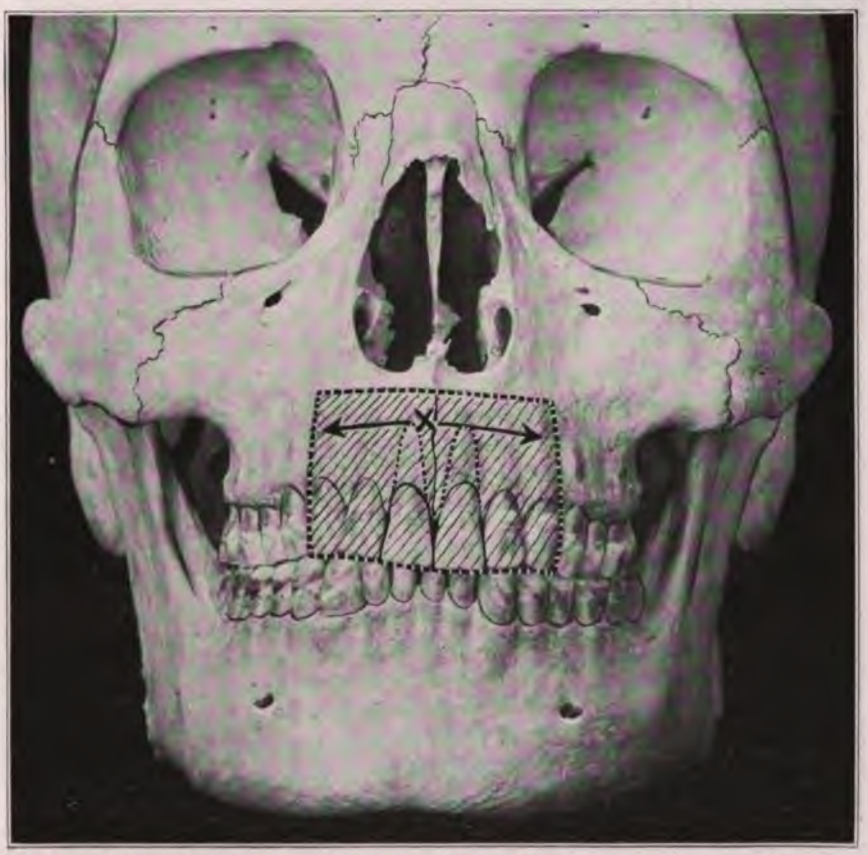


Fig. 329.—Diagram which illustrates the area of anesthesia which is secured by making an intraosseous injection between the apex of the central incisor and median line. The arrows indicate the diffusion of solution to the right and left sides following the discharging of the solution into the middle cancellous process.

one centimeter below the infraorbital margin and at the junction of the second and third fifths, starting at the median line. The chair should be elevated and the patient placed in a semisupine position. The operator should stand in front and at the side of the chair while making this injection. After the solution has been injected, the skin in the region of the infraorbital foramen should be gently massaged by a rotating motion. The solution must infiltrate through the infraorbital canal, an approximate distance of 5 mm. in order to reach the anterior superior dental nerve. (See Figs. 40 and 60.)

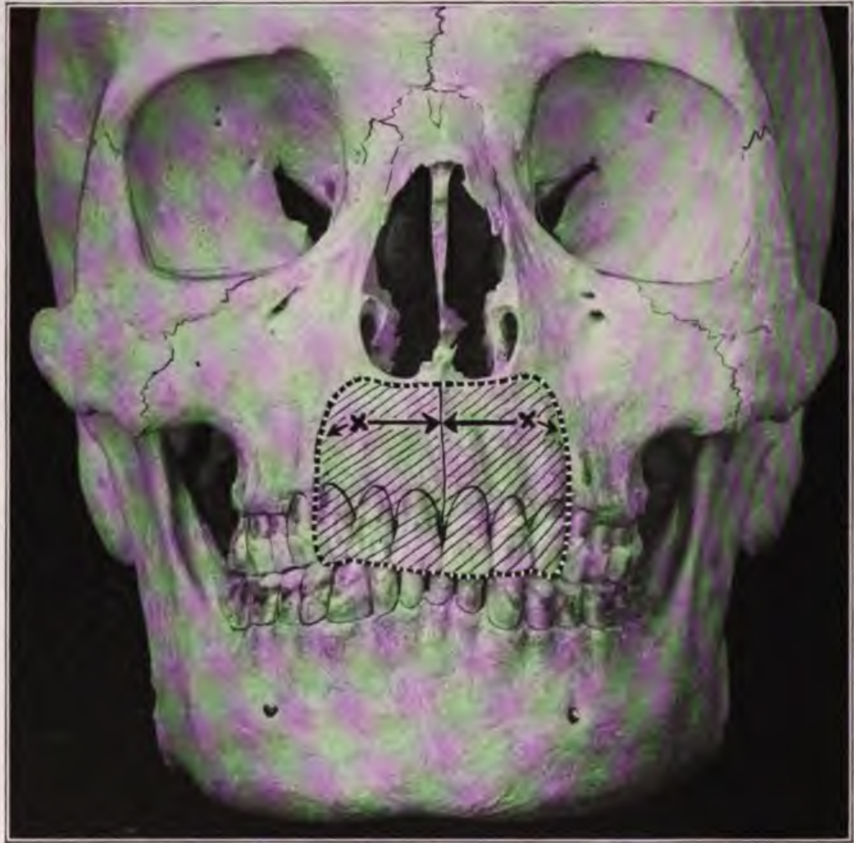


Fig. 330.—Diagram which illustrates the extent of anesthesia secured by two intraosseous injections which are made slightly above and between the apices of the lateral and cuspid teeth. The arrows in the center indicate the diffusion of solution towards the median line.

Injection of Solution.—The preliminary injection requires one-half mil of solution, which is injected into the skin prior to the insertion of the regular nerve blocking needle. After three minutes have elapsed following the preliminary injection, proceed with the deep injection by using the 30 mm., 25 gauge, needle, which is inserted through the anesthetized skin as given above to a depth approximately of 1 cm. until the region of the infraorbital foramen is reached, where two mils of solution are slowly injected. (See Fig. 335.)

Precautions.—The needle point is in contact with the periosteum in the immediate region of the foramen. (See Figs. 333 and 334.) Do not allow the needle to follow the periosteum. The bevel should be located towards the periosteum. It is seldom necessary to insert the needle to a greater depth than 1 cm., unless the tissues covering the region of the infraorbital foramen are very thick. With the technic previously given the needle approaches the opening of the infraorbital foramen more or less parallel with the outer portion of the infraorbital canal, and in many cases it would be possible to force the needle into the infraorbital canal, if it is advanced too far into the tissues. This should be avoided because there is some possibility of producing a hematoma by puncturing a blood vessel. There is greater possibility of puncturing a blood vessel when it is located within a foramen or canal, inasmuch as the artery or vein is held rigidly by connective tissue and can not escape from the needle. Always discharge the solution at the infraorbital foramen. While massaging do not use excessive pressure because it may injure a tender skin and produce an area of ecchymosis.

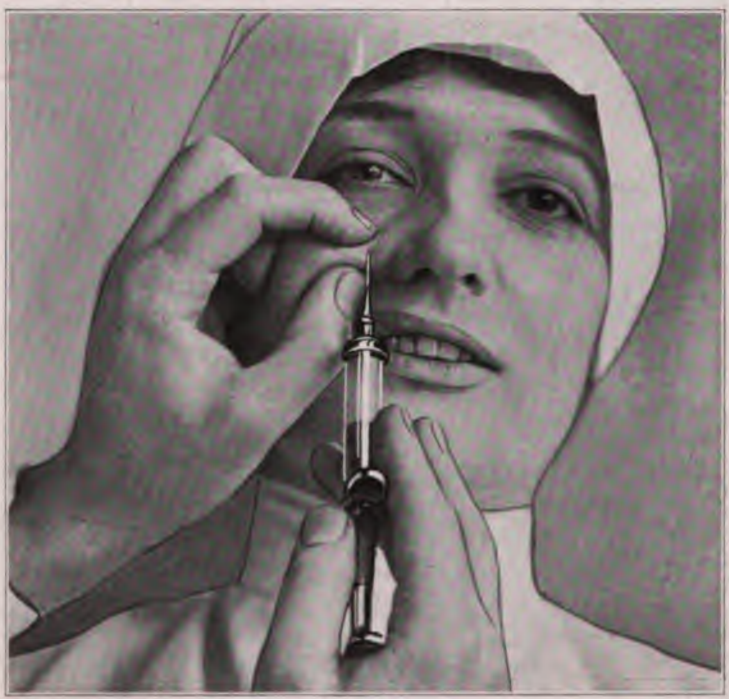


Fig. 331.—Making a preliminary injection in region of infraorbital foramen prior to inserting needle for extraoral infraorbital block injection.

Time to Wait for Anesthesia.—The time to wait for anesthesia is the same as for the intraoral method, which is from seven to ten minutes. Deep anesthesia will depend upon the skill of the operator in injecting the solution at the opening of the infraorbital foramen and massaging the tissues to force the solution into the infraorbital canal, to anesthetize the anterior superior dental nerve.

Structures Anesthetized.—The structures anesthetized following an extraoral infraorbital injection are the same as by the intraoral method. The reader is referred to page 474 for this information.

Indications for the Extraoral Infraorbital Method of Injection.—This injection is of value for oral and dental operations, also for plastic surgery. The extraoral is indicated over the intraoral method in case there is infection within the oral cavity in the region of the bicuspid teeth, at which point the needle is inserted by the intraoral method.

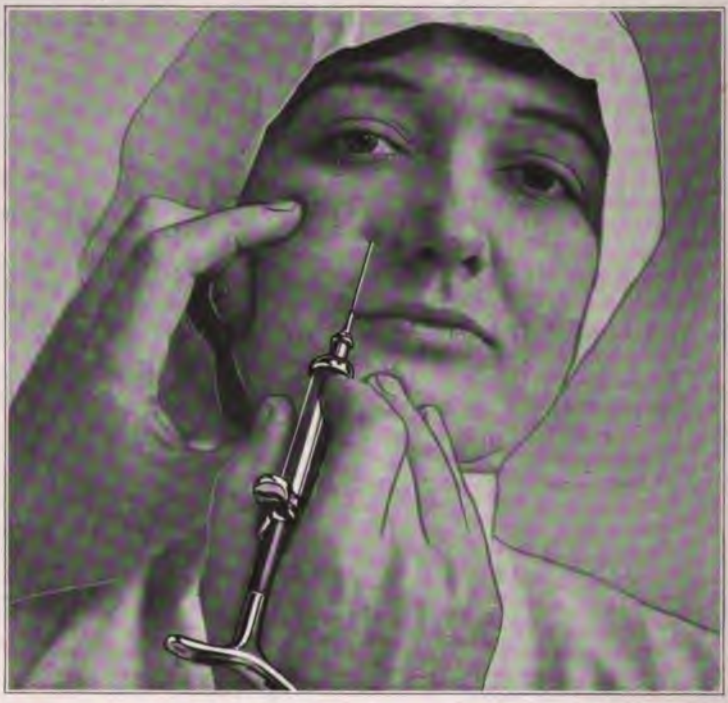


Fig. 332.—The position of needle while advancing same through the tissue in an upward and backward direction towards the infraorbital foramen.

Blocking the Interlacing or Overlapping Branches Following an Extraoral Infraorbital Injection.—The communicating branches from the opposite anterior superior dental nerve, and the branches from the middle superior dental nerve, must be blocked. The technic for blocking the interlacing branches has been given under the intraoral method on page 475.

BLOCKING THE UPPER RIGHT OR LEFT REGION OF THE SUPERIOR MAXILLARY BONE

If the operator desires to block one-half of the upper jaw or, in other words, the region occupied by the upper eight teeth, for either oral surgery or dental operations, either of the following methods may be employed:

1. Block the second division of the fifth nerve by the intraoral method.

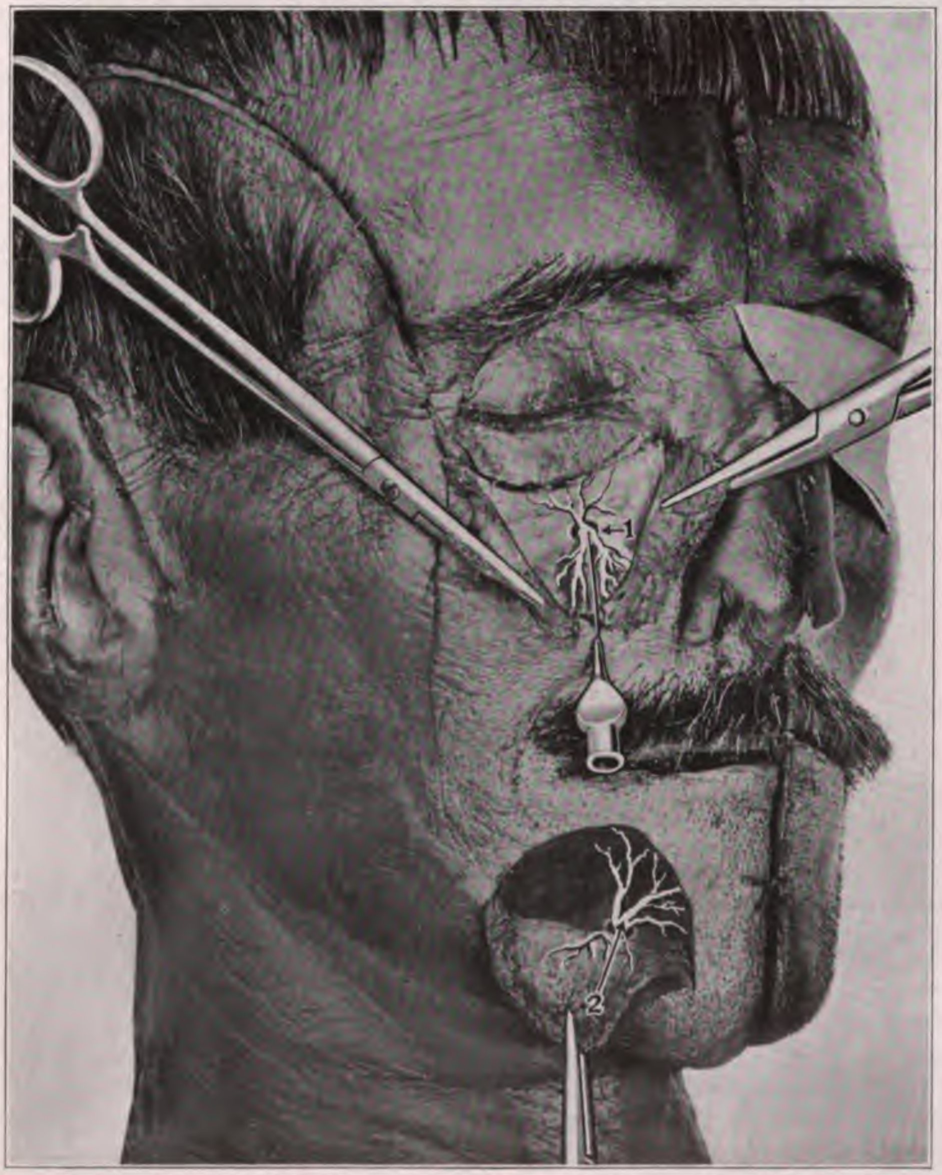


Fig. 333.—Needle in position at the infraorbital foramen for blocking infraorbital nerve by extraoral method.

1, the facial branches of infraorbital nerve; 2, mental nerve.

(See page 380 for technic.) In addition an infraorbital injection is made on the opposite side, (see page 459 for technic) or instead of the infraorbital, make an intraosseous injection, above and between the apices of the lateral and central incisor teeth, on the same side of the second division injection. (See page 489 for technic.)

2. Block the posterior superior dental nerve (see page 416 for technic), using two mils of solution. Make an intraosseous injection distal to and above the apex of the second bicuspid tooth, using 1½ mils of solution. (See technic on page 441). Make a second intraosseous injection above and between the apices of the central and lateral incisors on the same side, using 1½ mils of solution (page 489) or instead of the last intraosseous injection make an infraorbital injection on the same side (page 459) and in addition inject one mil of solution over the apices of the central and lateral incisor teeth on the opposite side to anesthetize the interlacing branches (page 483). If an intraosseous injection is made above and between the apices of the central and lateral incisor teeth on the side of operation, it is not necessary to make an extra

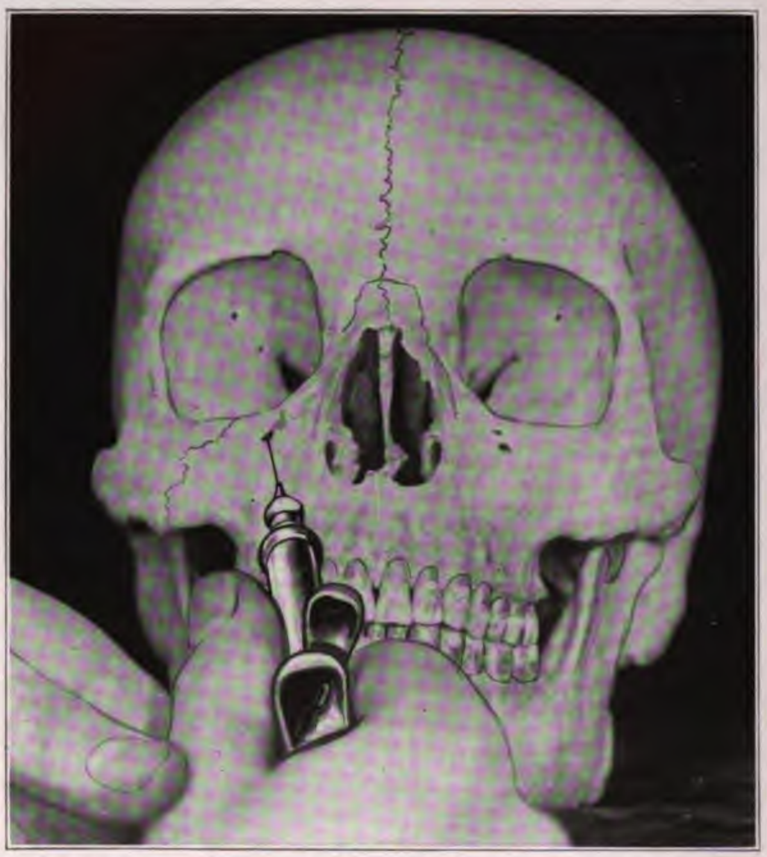


Fig. 334.—Needle point located at the infraorbital foramen during injection of solution by extraoral method.

injection for blocking the overlapping or interlacing nerve branches as when an infraorbital injection has been made.

The injections above enumerated under No. 2 will produce deep anesthesia for operating upon the teeth, alveolar process, buccal and labial structures. However, if the teeth are to be extracted, or if the lingual tissues are involved, then it is essential to block the anterior palatine nerve at the posterior palatine foramen (see page 501 for technic) and the nasopalatine nerve at the anterior palatine foramen. (See page 512 for technic.)

The injections as outlined under No. 1 will produce anesthesia of one-half of the upper jaw to the median line, including the buccal, labial and lingual tissues, with the exception of the area supplied by the branches of the nasopalatine nerve. Inject one-half mil of solution at the anterior palatine foramen to anesthetize the terminal interlacing branches of the nasopalatine nerve from opposite side.

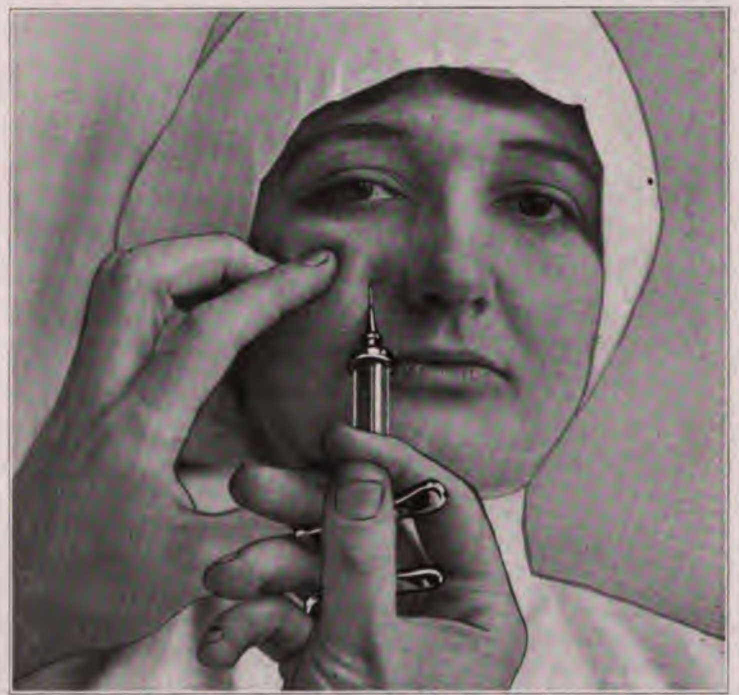


Fig. 335.—Position of syringe and needle while injecting the solution at the infraorbital foramen.

BLOCKING THE ANTERIOR PALATINE NERVE

Topography of Anatomy.—The nervous anatomy of the anterior palatine nerve has already been described in detail in Chapter VII, consequently only a brief synopsis of the anatomy for this injection will be given at this time. The anterior palatine nerve is derived from Meckel's ganglion (spheno-palatine ganglion), which is situated in the sphenomaxillary fossa, together with the middle, posterior and nasopalatine branches. (See Figs. 40, 48, 53, 54A, and

60.) The anterior palatine branch is the largest of the four palatine branches. (See Figs. 60, 80, 97 and 98.) The direction of the anterior palatine nerve is downward and anteriorly. It enters the posterior palatine canal and emerges from the undersurface of the palate through the posterior palatine foramen (see Fig. 34) and immediately divides into numerous branches which sup-

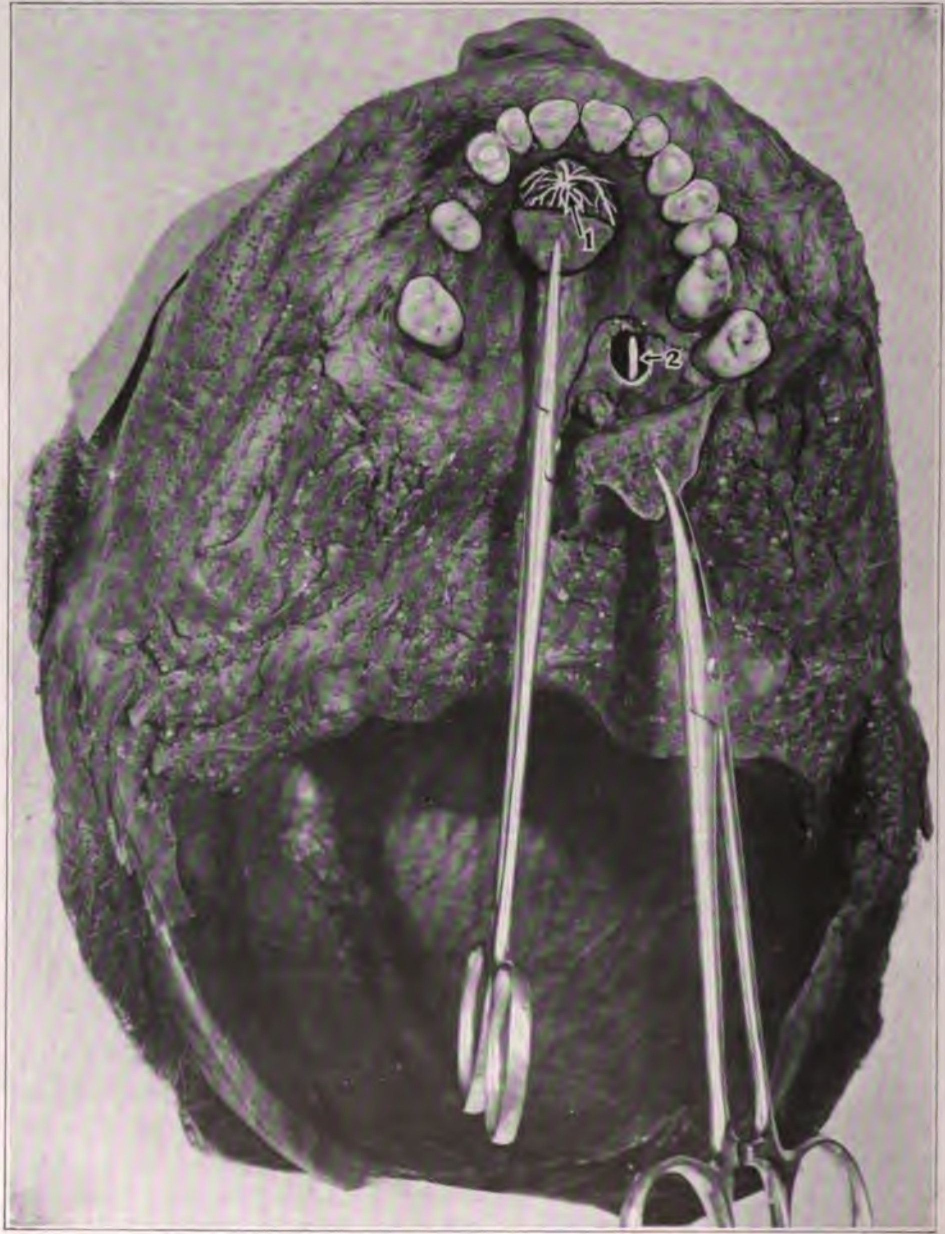


Fig. 336.—1, nasopalatine nerves at anterior palatine foramen exposed by removal of flap; 2, anterior palatine nerve at the posterior palatine nerve exposed by removal of flap.

ply the mucous membrane, gum tissue and periosteum of the palate. The posterior palatine foramen is located midway between the linguo-gingival margin of the upper third molar and median line, and from 3 to 6 mm. anterior to the junction of the hard and soft palates. (See Figs. 81 and 98.) This nerve is accompanied by the palatine arteries and veins and passes anteriorly at the angle formed between the linguo-alveolar plate and roof of the mouth. (See Figs. 77, 81 and 98.) The anterior palatine nerve gives

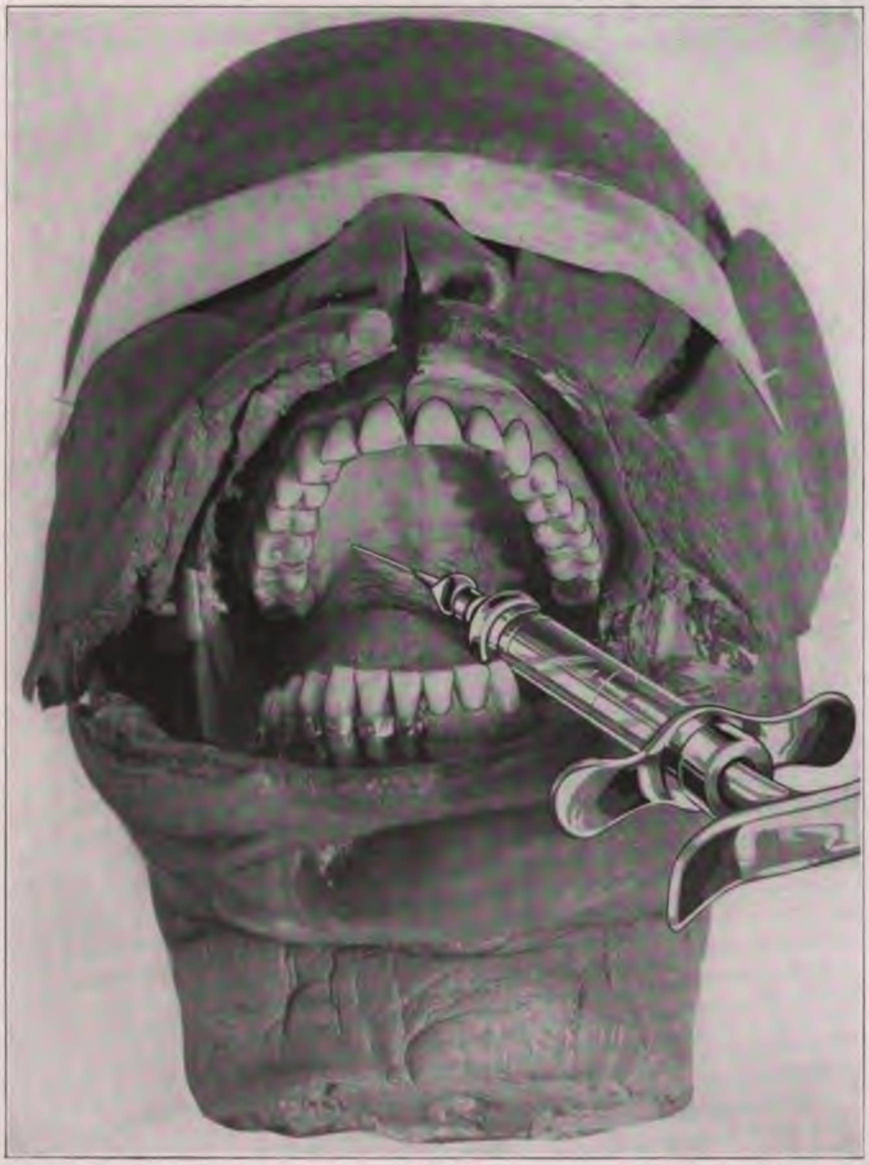


Fig. 337.—Position of syringe and needle while discharging the solution at the posterior palatine foramen for blocking the anterior palatine nerve.

off numerous branches which supply the lingual periosteum and gum tissue as far anteriorly as the distal surface of the apex of the cuspid tooth, at which point the terminal branches overlap the terminal branches of the nasopalatine nerve, where the inner nerve loop is completed. See Fig. 81. The small branches from the anterior palatine nerve pass to the median line and overlap the branches from the opposite side which supply the roof of the mouth with sensation. In most cases a depression in the gum tissue and mucous membrane is seen directly over the posterior palatine foramen. Following the examination of a large number of skulls it was found that the anterior palatine nerve, veins and arteries are located in a depression or groove in the bone situated at the angle formed between the linguoalveolar plate and roof of the mouth. The reader will notice by referring to Fig. 81 that the main branch of the anterior palatine nerve is located approximately midway between the median line and the linguogingival margin of the upper teeth, and that small branches given off the main branch, pass upward along the linguoalveolar plate to supply the periosteum and gum tissue of that region.

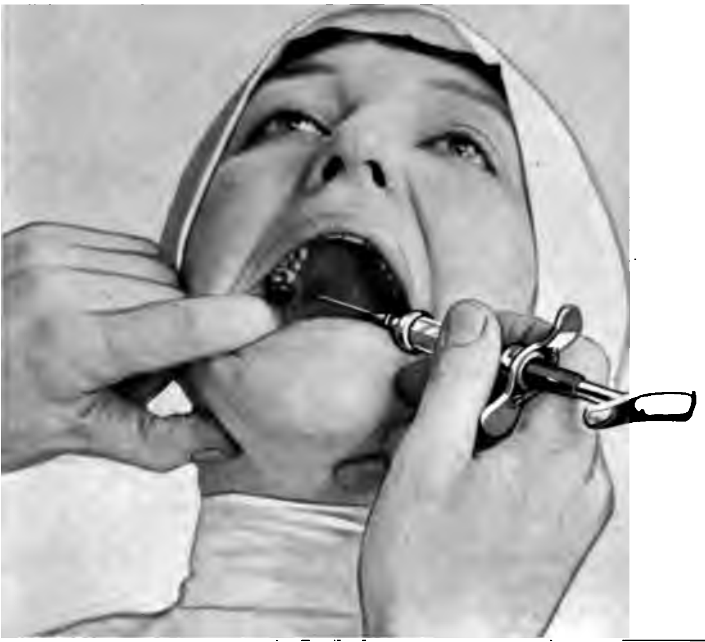


Fig. 338. Starting the needle into the tissue midway between the lingo-gingival margin of third molar and median line for blocking the anterior palatine nerve.

Needle Employed.—The needle employed for blocking the anterior palatine nerve is No. 4, 30 mm. in length, and 25 gauge. (See Fig. 177.)

Technic of Injection.—The technic for blocking the anterior palatine nerve as it emerges from the posterior palatine foramen, is as follows: The chair is raised and the patient is placed in a semisupine position. (See Fig. 570.) The operator should stand in front and at the side of his patient. The syringe is filled with one-half mil of solution. Prepare an area at least two centimeters in diameter, in the region of the posterior palatine foramen. The needle is inserted into the tissue midway between the linguogingival margin of the upper third molar and median line. (See Figs. 337 and 338.) The barrel of the syringe occupies a position over the lower cuspid and first bicuspid teeth across the mouth as is illustrated in Fig. 339. The needle is advanced upward, backward and outward to an approximate depth of 1 cm. At this depth the needle will in most cases strike the periosteum in the region of the posterior palatine foramen. (See Fig. 340.) One-half mil of the solution is now slowly injected. In case this nerve is being blocked for a child, in whom the third molar has not yet erupted, the upper second molar is used as a guide instead of the upper third molar. In case the upper third molar is missing, then place the index finger posterior to the posterior palatine foramen and locate the posterior margin of the hard palate at the junction of the hard and soft palates. The needle is then inserted from three to six millimeters anterior to the junction of the hard and soft palates and midway between the center of the alveolar ridge and median line. The needle approaches the foramen at an acute angle, which makes it difficult or impossible for it to enter the foramen or canal any considerable distance.

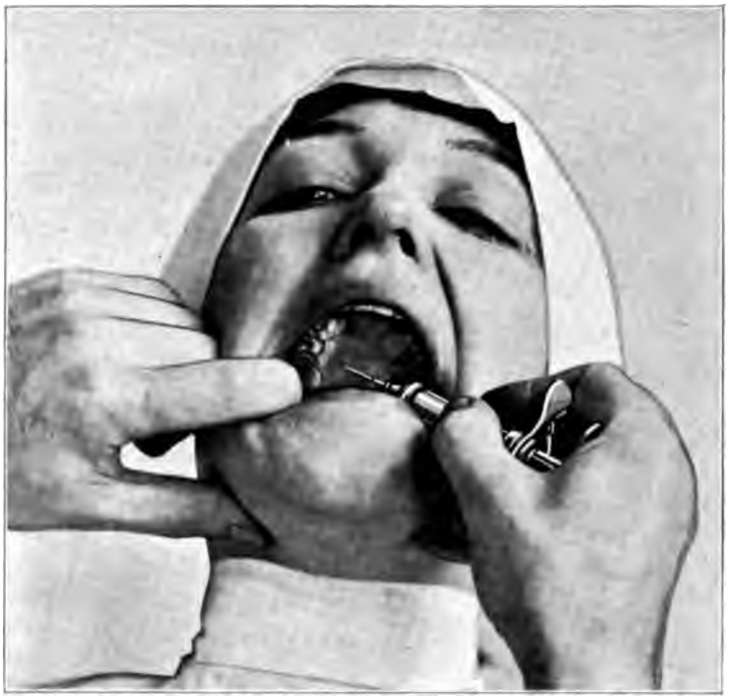


Fig. 339. Position of syringe while discharging the solution at the posterior palatine foramen. The barrel of syringe occupies a position over the lower cuspid and first bicuspid teeth.

Injection of Solution.—The syringe should be held in the hand in the same manner as a pen while writing, as illustrated in Fig. 338. The amount of solution injected is one-half mil. No more than this amount should be injected because it will infiltrate posteriorly, producing partial or complete anesthesia of the branches of the middle and posterior palatine nerves which supply the mucosa, soft palate, uvula, anterior pillar, posterior pillar, and other issues in that region, which causes considerable inconvenience to the patient, as it will produce an uncomfortable feeling, probably gagging and difficult deglutition. One-half mil of solution will produce almost immediate anesthesia of the anterior palatine nerve as it emerges from the posterior palatine foramen, and will not cause any disagreeable after-affects.

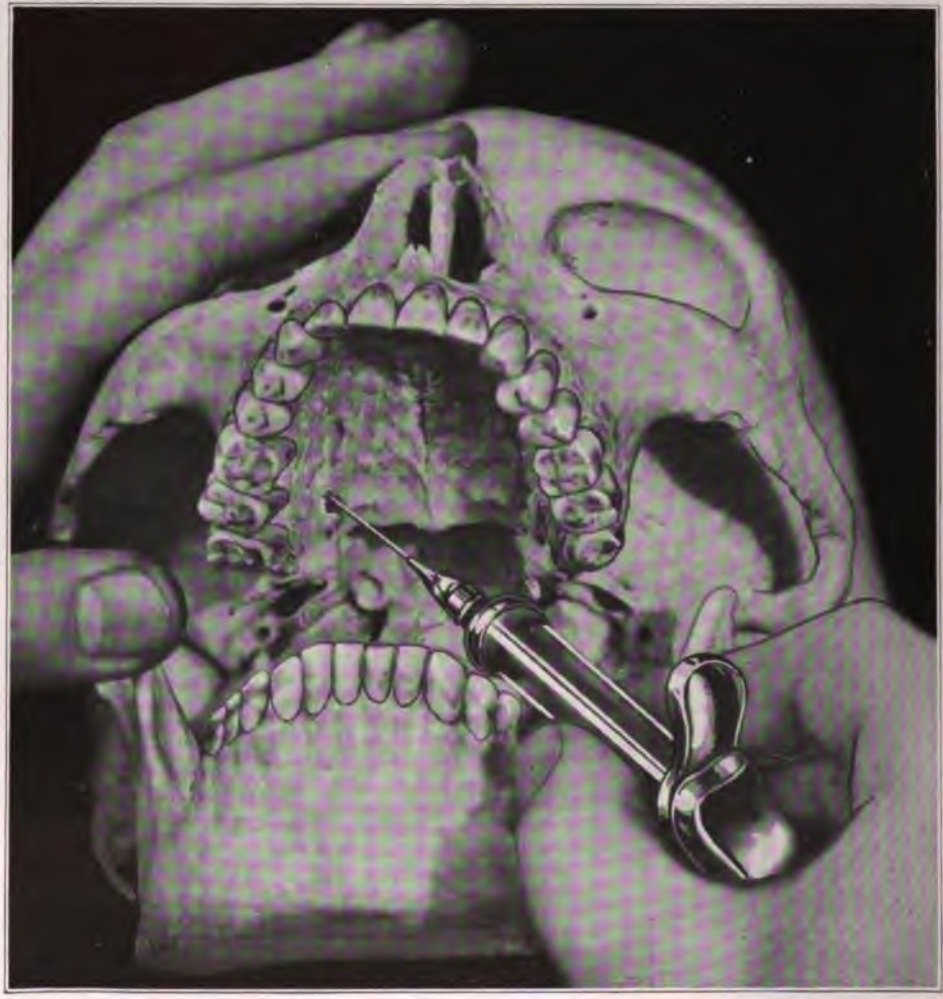


Fig. 340.—Point of needle in region of posterior palatine foramen for blocking the anterior palatine nerve.

Precautions.—The needle should never be inserted posterior to the posterior palatine foramen because the anterior palatine nerve, as it emerges from the foramen, passes immediately anteriorly in the roof of the mouth. (See Fig. 81.) The solution should be injected very slowly, so as not to force it into the region of the soft palate for reasons previously cited.

Time to Wait for Anesthesia.—Profound anesthesia of the tissues supplied by the anterior palatine nerve is produced in one minute.

Structures Anesthetized.—The tissues anesthetized by blocking the anterior palatine nerve are a small portion of the soft palate, lingual gum tissue and periosteum covering the linguoalveolar plate to a point near the median line and extending anteriorly as far as the distal surface of the cuspid tooth.

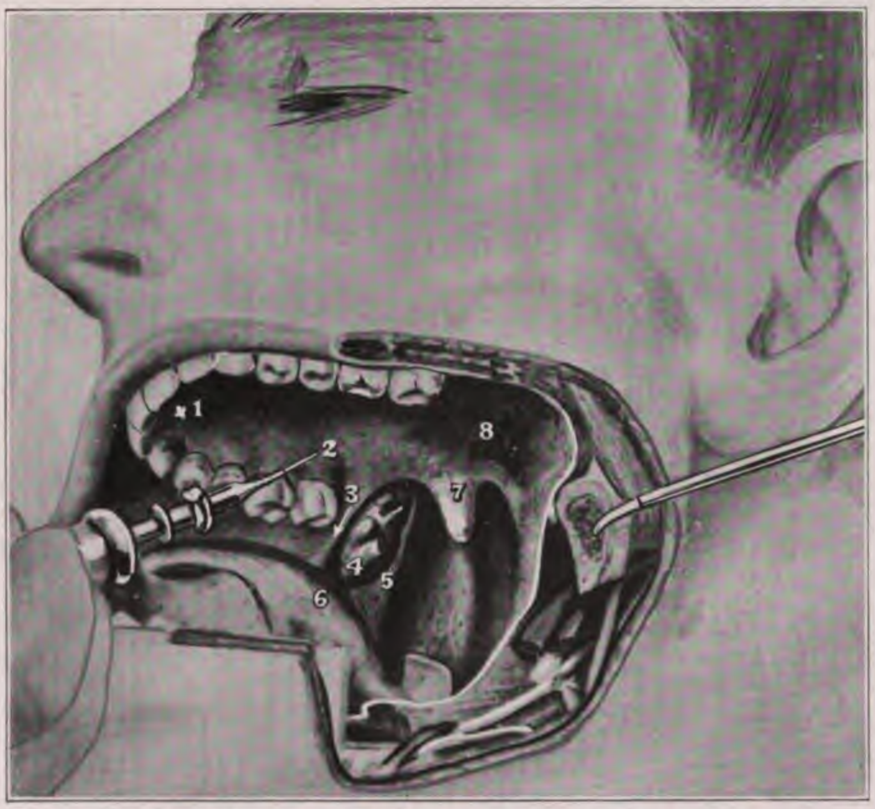


Fig. 341.—Location of puncture point for blocking anterior palatine nerve.

1, anterior palatine foramen; 2, posterior palatine foramen; 3, anterior pillar of tonsil; 4, tonsil; 5, posterior pillar; 6, dorsum of tongue; 7, uvula; 8, soft palate.

Blocking the Interlacing or Overlapping Branches.—The anterior palatine nerve passes anteriorly along the roof of the mouth and its several branches overlap the terminal branches from the nasopalatine nerve lingual to the cuspid tooth. (See Fig. 81.) In other words, the cuspid is the dividing line between the anterior and nasopalatine nerves, and the tissues lingual to this tooth are supplied by branches from these two nerves. If an operation is to be performed on the tissues situated near the median line, then it becomes necessary to block the anterior palatine nerve on the opposite side because the tissues in the roof of the mouth in the median line are supplied from both the right and left anterior palatine branches. (See Fig. 81.) If the part to be operated extends as far anteriorly as the lingual surface of the cuspid tooth, it is necessary to block the overlapping branches from the nasopalatine nerve by injecting the solution lingual to the apex of the cuspid or lateral incisor.

Use of Anterior Palatine Block Injection.—The anterior palatine nerve must be blocked when the lingual tissues are included in the operation for such cases as the extraction of teeth, or for an oral operation upon the lingual tissue. It is not necessary to block this nerve for dental operations upon the teeth themselves, because the anterior palatine nerve has nothing to do with the nerve supply of the alveolar process, teeth, or buccal tissues. Many dentists have made the mistake of blocking the anterior palatine and nasopalatine nerves, for operations, such as cavity preparation, pulp removal, or shaping the crowns for bridge abutments, etc. If the teeth, alveolar process, buccal or labial structures only, are involved in the operation, the anterior palatine is not blocked, but only the outer nerve loop or a portion of it is anesthetized. If the reader is familiar with nervous anatomy, he will make no mistake in blocking a nerve branch which is not necessary for the operation in question.

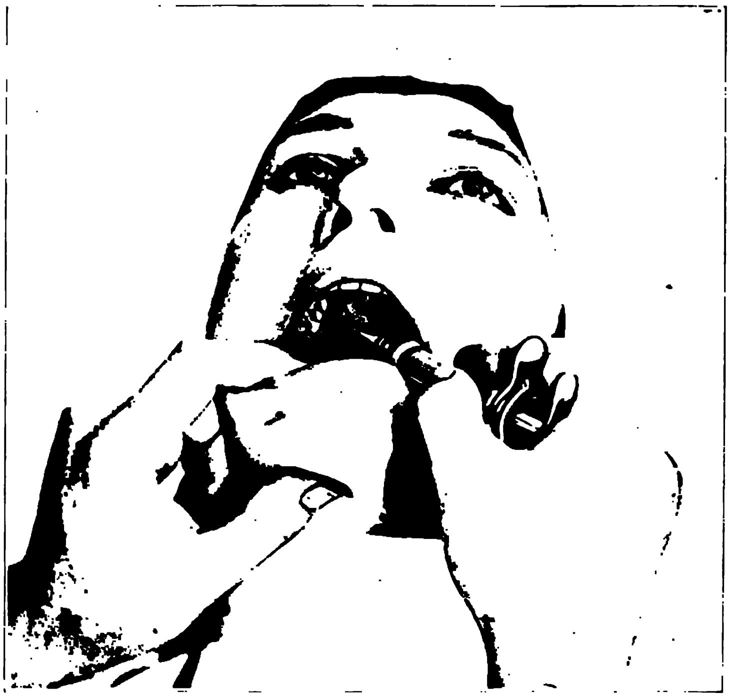


Fig. [illegible] Position of syringe and needle for blocking the anterior palatine nerve lingual to upper first molar. (See Figs. 343 and 344.)

BLOCKING THE ANTERIOR PALATINE NERVE ANTERIOR TO THE POSTERIOR PALATINE FORAMEN

In producing anesthesia the operator should inject as little solution as possible with as few punctures of the tissue as possible. It is not considered good practice to block the tissues extending over any larger area than necessary. *In case the upper third molar is not included in the operation*, then block the anterior palatine nerve by inserting the needle midway between the linguogingival margin of the upper second molar and the median line. It must be remembered that the anterior palatine nerve passes anteriorly from the posterior palatine foramen, and by injecting the solution as above given, which is lingual to the

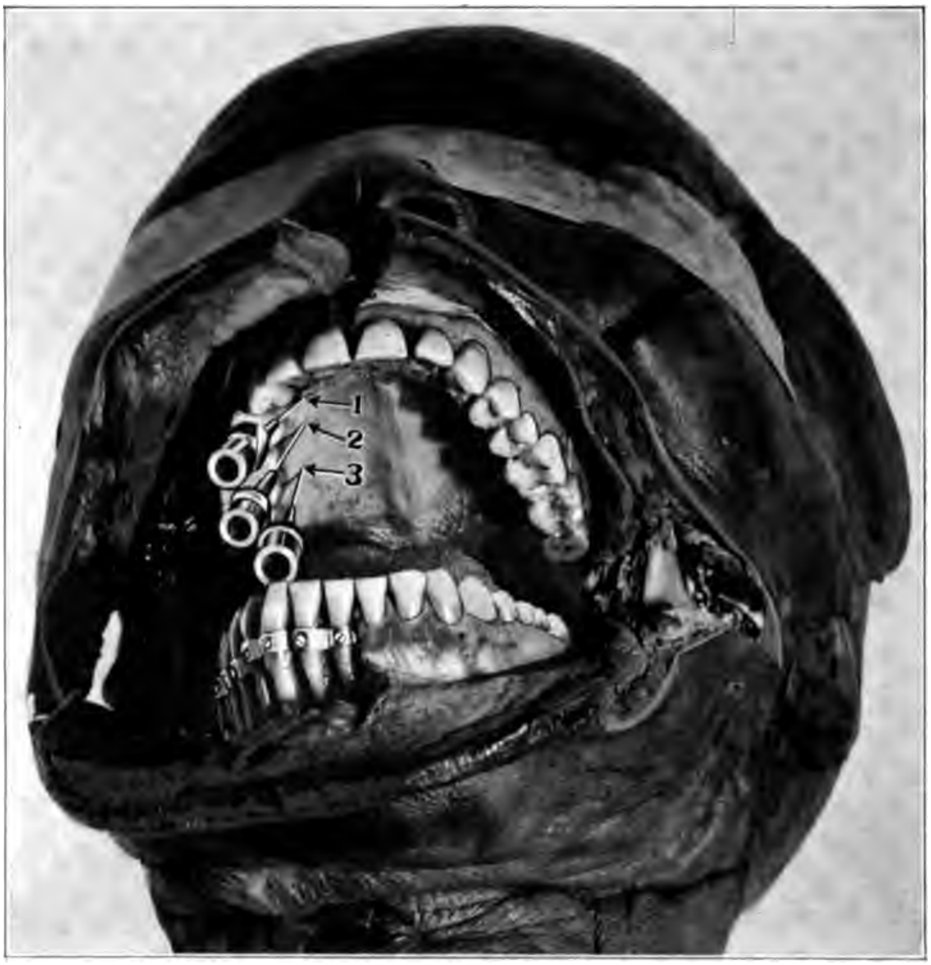


Fig. 343.—Wet specimen illustrating positions for blocking the anterior palatine nerve anterior to posterior palatine foramen.

1, position of needle for blocking the overlapping branches of anterior palatine and nasopalatine branches lingual to apex of cuspid tooth; 2, position of needle for blocking anterior palatine nerve lingual to upper bicuspids; 3, position of needle for blocking anterior palatine nerve lingual to upper first molar. (See Fig. 344.)

apex of the lingual root of the upper second molar, anesthesia will not be produced in the tissues lingual to the upper third molar. The amount of solution injected is one-half mil, and the technic is similar to that of blocking the nerve at the posterior palatine foramen, as given on page 501.

If the region of the upper second and third molars is not included, then block the anterior palatine nerve, using the same technic and quantity of solution as mentioned previously, by inserting the needle to the lingual of the apex of the lingual root of the upper first molar; that is, midway between the linguogingival margin of the upper first molar and median line. (See Figs. 342, 343 and 344.) Anesthesia will be produced in the lingual gum tissue and periosteum as far anteriorly as the distal surface of the cuspid tooth.

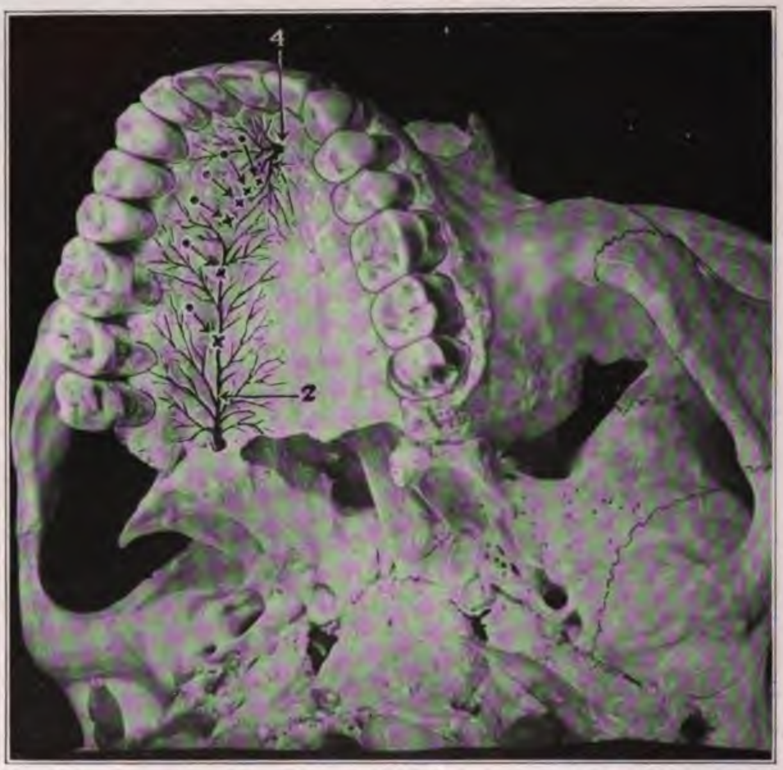


Fig. 344.—Showing points of insertion and points of injection for blocking nerves of palate. 2, anterior palatine nerve; 4, nasopalatine nerve; dots represent points of insertion of needle and (x) represents the points of injection of solution.

In case the lingual tissue is to be anesthetized to the lingual of the upper two bicuspid teeth, block the anterior palatine nerve lingual to the apex of the second bicuspid tooth, or, in other words, midway between the linguogingival margin of the second bicuspid and the median line. Inject one-half mil of solution. (See Figs. 343 and 344.)

If the upper first bicuspid tooth is alone involved, one should then block the anterior palatine nerve by injecting the solution to the lingual of the apex of the first bicuspid root. (See Figs. 343 and 344.)

Blocking the Terminal or Overlapping Branches of the Naso- and Anterior Palatine Nerves Lingually to the Upper Cuspid Tooth.—This region is supplied by nerves from two different sources. However, a single injection suffices to block the area. Needle No. 4 is employed and is inserted midway between the linguo-gingival margin and the apex of the cuspid tooth, holding the syringe across the arch as illustrated in Fig. 345. When the needle reaches the linguoalveolar plate three minims of solution are injected. The needle is now changed to a position parallel with the linguoalveolar plate, and is advanced upward until it reaches the hard palate, at which location one-half mil of the solution is slowly injected, which will anesthetize the terminal branches of both the anterior and nasopalatine nerves. (See Figs. 343 and 344.) If it is desired to include the area lingual to the upper eight anterior teeth, that is, first bicuspid on the right to first bicuspid on the left, then make the following injections:

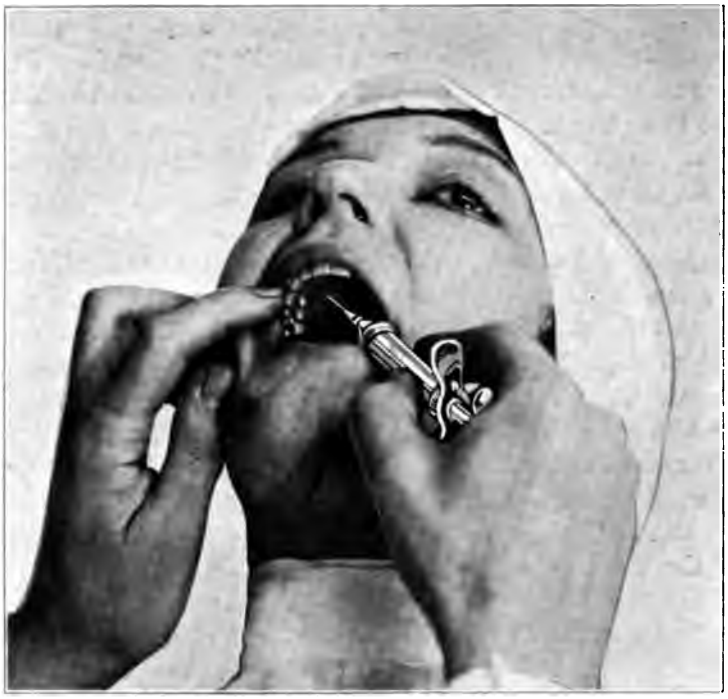


Fig. 345.- Position of syringe and needle for blocking the overlapping branches of the anterior palatine and nasopalatine nerves situated lingual to apex of cuspid. (See Fig. 344.)

1. Block the nasopalatine nerves as they emerge from the anterior palatine foramen. (See page 512 for technic.)

2. Block the branches of both right and left anterior palatine nerves by inserting the needle midway between the linguogingival margin and apex

of the first bicuspid tooth. (See Figs. 343 and 344.) The technic is identical with that given above for blocking lingually to the apex of the cuspid tooth. In case the upper second bicuspids on both sides are included with the anterior teeth, then block the anterior palatine by injecting one-half mil of solution lingually to the apex of the second bicuspid.

BLOCKING THE NASOPALATINE NERVE

Topography of Anatomy.—For a detailed description of the nasopalatine nerve, the reader is referred to Chapter VII and only a brief description will be given here.

The nasopalatine nerve arises from Meckel's ganglion (see Figs. 40 and 60) in the sphenomaxillary fossa. (See Figs. 48, 53 and 54A.) The distance between the two ganglia is from one and a quarter to one and a half inches. The course of this nerve from the ganglion is downward, forward and inward. (See Figs. 40, 60 and 77.) It takes this course until it reaches the superior posterior portion of the nasal septum in the median line. After reaching the nasal septum, it passes downward and forward, and is situated beneath the mucous membrane and periosteum which covers the nasal septum. It emerges upon the surface of the hard palate through the anterior palatine foramen. (See Figs. 34 and 97.) The anterior palatine foramen is located in the median line, in most cases approximately 1 cm. distal to the linguogingival margin of the central incisors in the median line, and is formed by the articulation of the two superior maxillary bones. (See Fig. 80.) In the majority of cases, the right and left nasopalatine nerves pass through a single foramen which is called the anterior palatine foramen, which is formed by the union of the two foramina of Scarpa and two foramina of Stenson. (See Fig. 38.) The superior posterior nasal septum is formed by the perpendicular plate of the ethmoid; the lower posterior by the vomer which articulates in the median line with the two superior maxillary bones. The anterior portion is formed by cartilage. The above named bones and cartilage which form the nasal septum are covered on both sides by periosteum and mucous membrane. Immediately after the nasopalatine nerves emerge from the anterior palatine foramen, they form a plexus which divides into numerous branches (see Figs. 81 and 82) which supply the periosteum and gum tissue covering the lingual plate in the region of the central and lateral incisors and as far distally as the lingual surface of the cuspid. The nasopalatine nerve is smaller than the anterior palatine.

Needle Employed.—The gum tissue, mucous membrane and periosteum, located in the region of the anterior palatine foramen, is very sensitive, due to the abundant nerve supply, and it is good practice to make a preliminary injection with a very fine, sharp needle, such as needle No. 7. Following the preliminary injection, needle No. 3, 15 mm. in length, and 24 gauge, is employed to inject the solution near the anterior palatine foramen.

Technic of Injection.—After preparing the tissue, the following technic is employed: The syringe is filled with one mil of solution and the preliminary needle is mounted upon the syringe. The tissue in the region of the anterior palatine foramen is quite dense and is richly supplied with nerve fibers, besides the nerve plexus located in this immediate region, makes the tissue hypersensitive. Extreme care should be taken in advancing the small sharp needle into the tissue in this region as it may cause the patient unnecessary pain. After the needle point has been advanced beneath the tissue surface, inject three minims of solution, and after waiting two minutes, place

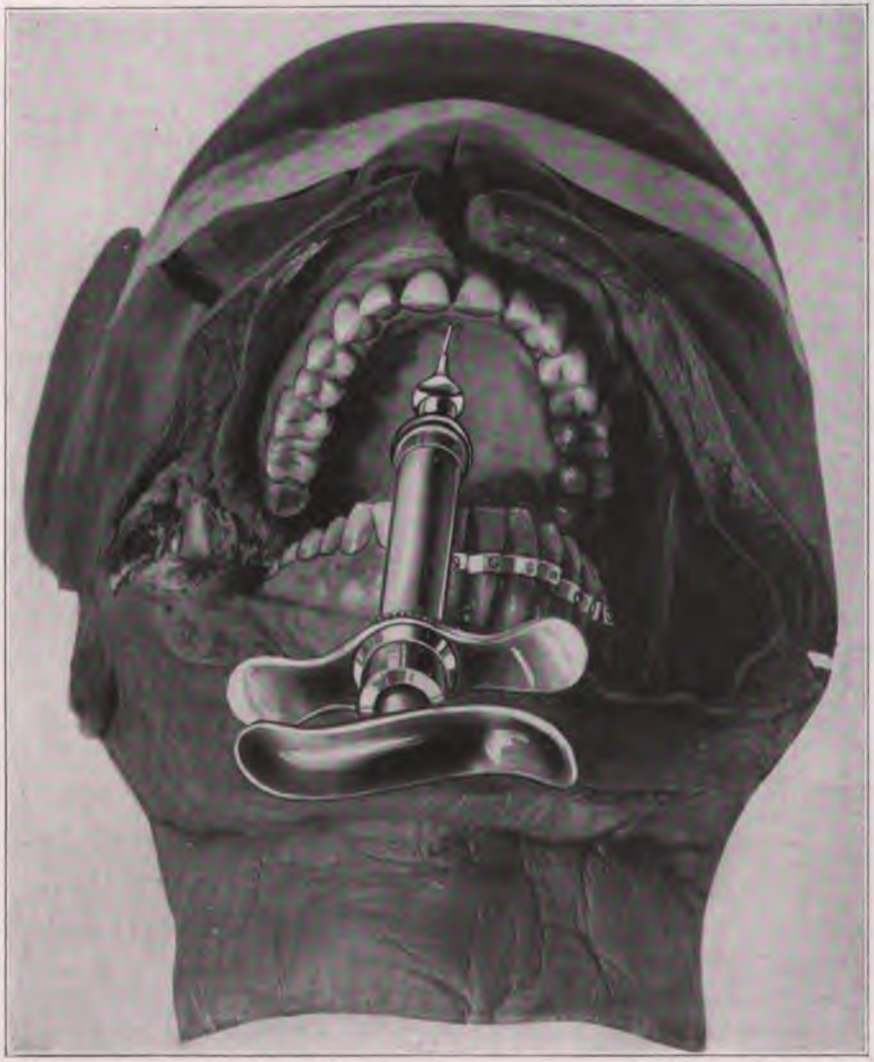


Fig. 346.—Syringe in position for discharging solution at anterior palatine foramen for blocking nasopalatine nerves.

needle No. 3 on the syringe. Now puncture the tissue at the side of the median line, distal to the rugæ, by holding the barrel of the syringe in the median line and resting upon the lower central incisors, as illustrated in Figs. 346 and 347. The needle is now carefully advanced from ½ to 1 cm. upward and backward through the tissue which has been anesthetized by the preliminary injection. At this depth, in most cases, the needle will come in contact with the periosteum in the region of the foramen. (See Fig. 348.) While the solution is being injected, the needle point should be situated on either the right or left side of the anterior palatine foramen. If the needle is inserted directly into the median line and advanced upwards and backwards, there is some possibility of it entering the foramen and canal. Of all the intraoral nerve blocking injections, this is the most sensitive region in which to insert the needle. The chair should be elevated and the patient placed in a semisupine position. The operator should stand in front and at the side of his patient. The patient's head should be tipped backward as far as possible in order to expose the area of injection. (See Fig. 349.)

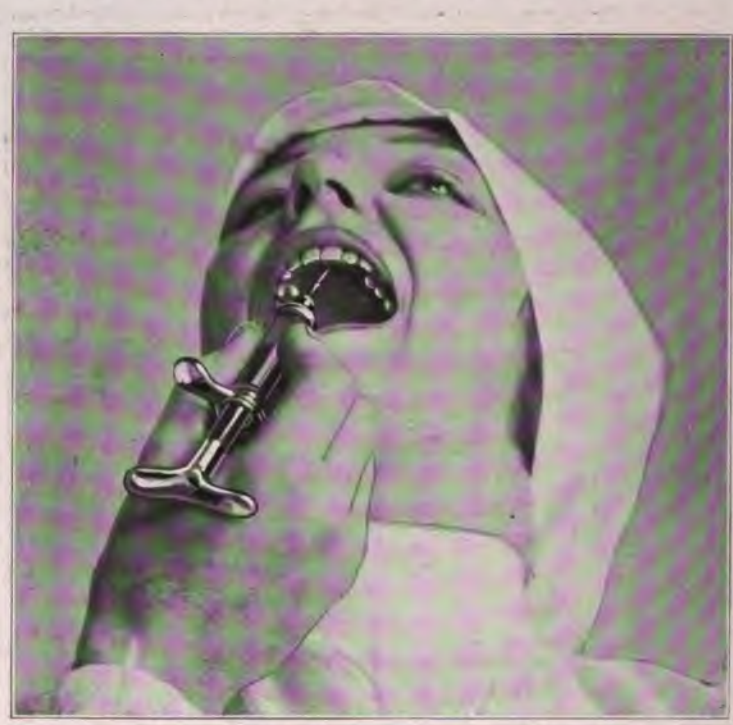


Fig. 347.—Position of syringe while advancing the needle towards the anterior palatine foramen.

Injection of Solution.—Three minims of the solution are slowly injected with the preliminary needle which anesthetizes the superficial tissues. After two minutes following the preliminary injection, insert needle No. 3 through the anesthetized tissue as above described and inject one-half mil. (See Fig. 349.) In some cases considerable pressure is required to discharge the solution, because the tissues in this region are very dense. It is an advantage to move the syringe slightly back and forth while discharging the solution.

Precautions.—Do not advance the needle into the region of the anterior palatine foramen with force, because this will cause the patient unnecessary pain. Never insert the needle to a greater depth than one centimeter. The solution should be injected very slowly so as to guard against inflicting pain which would be caused by rapid distention of the tissues.

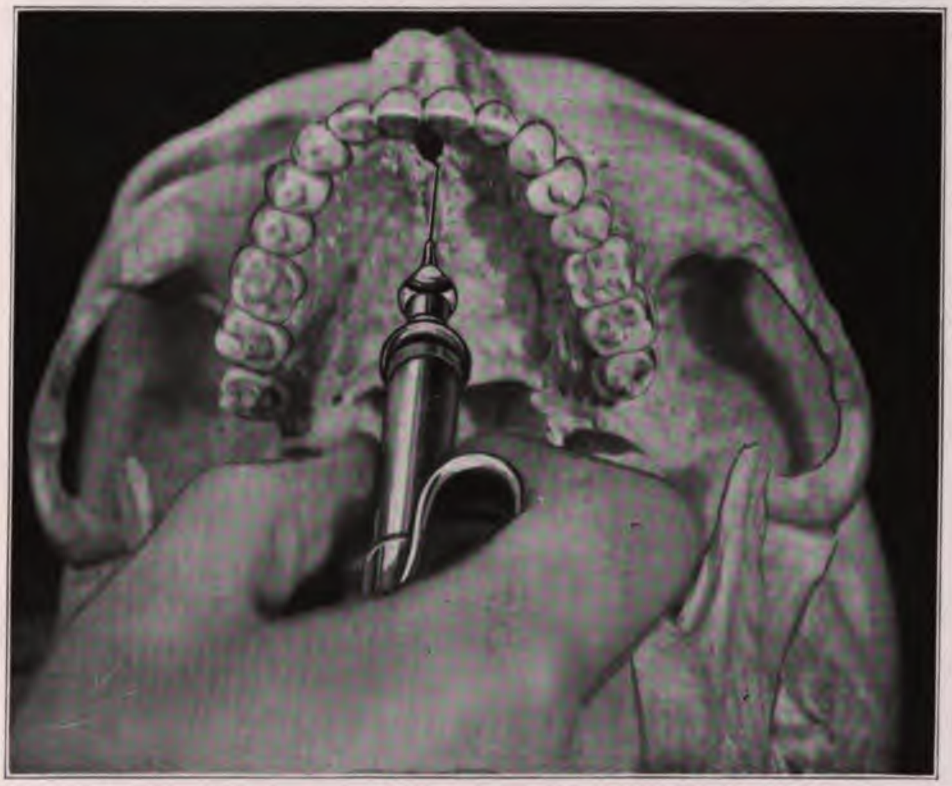


Fig. 348.—The needle point located near the anterior palatine foramen while blocking the nasopalatine nerves.

Time to Wait for Anesthesia.—The time to wait for anesthesia following the blocking of the nasopalatine nerves as they emerge from the anterior palatine foramen is in most cases not to exceed one minute. The solution comes in immediate contact with the nerves and very little time is required for the solution to thoroughly permeate them.

Structures Anesthetized.—The structures anesthetized are the mucosa, lingual gum tissue and periosteum which covers the linguo-alveolar plate as far distally as the mesial surface of the cuspid teeth. The operator must remember that both the right and left nasopalatine nerves pass out of the anterior palatine foramen and immediately form a plexus from which arise numerous branches. By depositing the solution in the region of the foramen, the right and left nasopalatine nerves and their branches are blocked. The nasopalatine nerves must be anesthetized for the extraction of the upper central and lateral incisor teeth, or for any other operation which involves the lingual tissues, such as for the treatment of pyorrhea alveolaris. For dental operations which involve the teeth or labial structures only, it is not necessary to make a nasopalatine injection.

Blocking the Tissues Lingually to the Upper Six Anterior Teeth.—As previously stated, the right and left nasopalatine nerves supply the gum tissue and periosteum lingual to the centrals and laterals. The terminal branches of the nasopalatine overlap the terminal branches from the anterior palatine on the lingual side of the upper cuspid tooth. (See Fig. 81.) Therefore, if the cuspid region is to be included in the operation with the central and lateral incisors, it is not only necessary to block the right and left nasopalatine nerves at the anterior palatine foramen (see Figs. 349, 350, and 351), but in addition block the communicating branches from the anterior palatine nerve on the lingual side of the cuspid tooth. (See Figs. 344 and 345.) If the terminal branches of the anterior palatine nerve are not blocked, and an attempt is made to extract the cuspid tooth the lingual beak of the forceps would cause pain, because the gum tissue and periosteum lingual to the cuspid is supplied from both the nasopalatine and anterior palatine nerves. In case

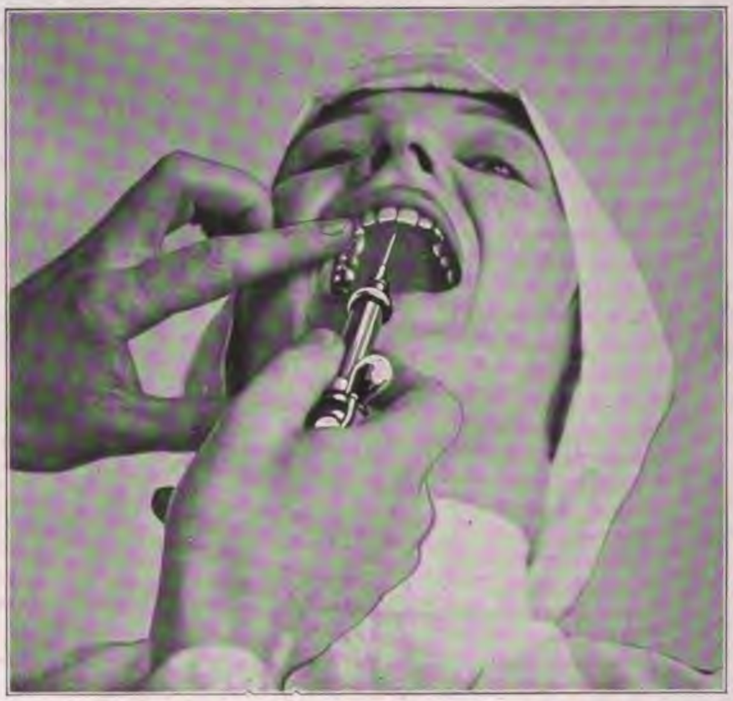


Fig. 349.—The barrel of syringe is located over the lower incisor teeth while discharging the solution near the anterior palatine foramen for blocking the nasopalatine nerves.

the tissue is involved lingual to the centrals, laterals and cuspid teeth on both sides of the median line, it is necessary to make three injections, namely, (1) nasopalatine; (2 and 3) right and left injections lingual to the apex of the cuspid tooth. Each injection requires one-half mil of solution.

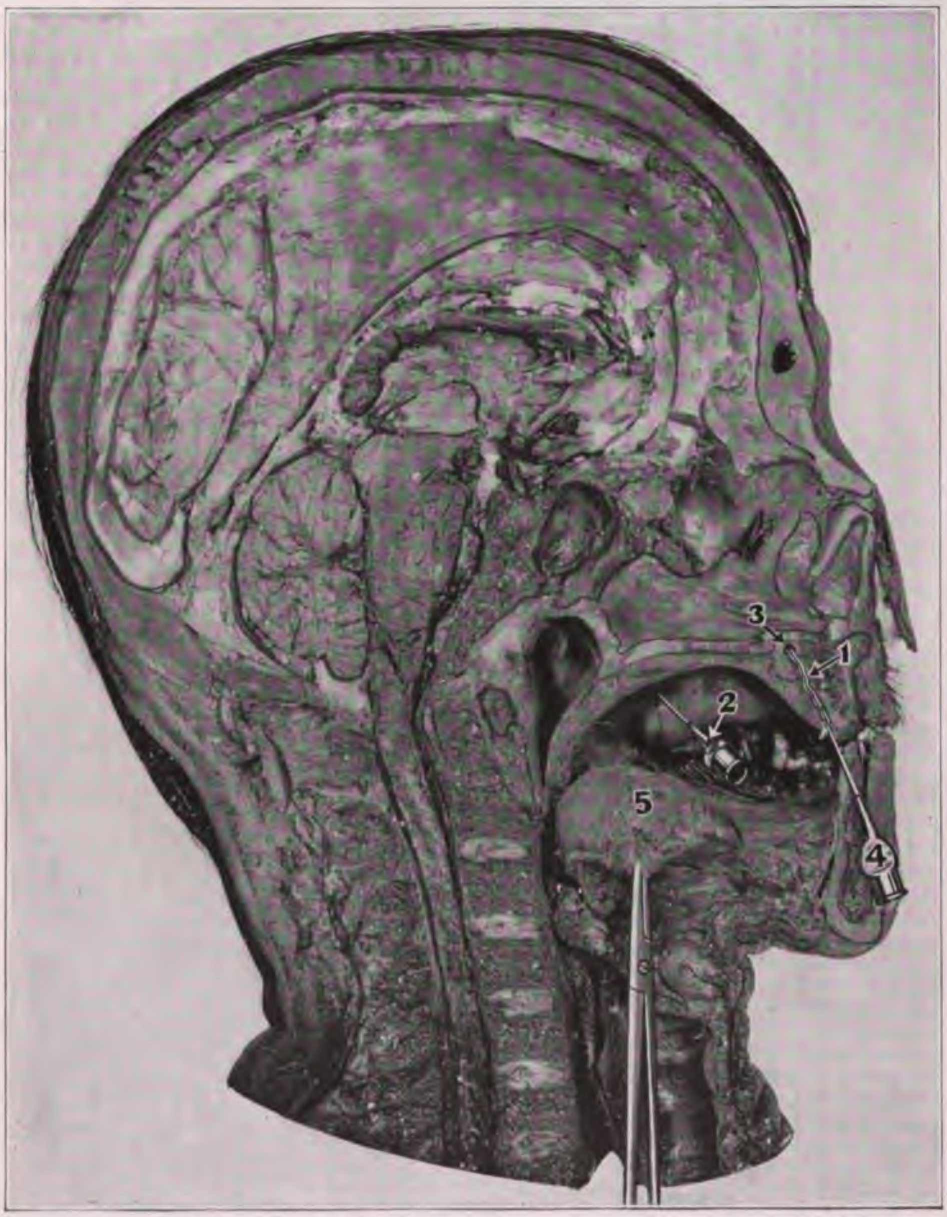


Fig. 350.—Median section of wet anatomical specimen, illustrating the following:

1, nasopalatine nerve; 2, needle in position for blocking the anterior palatine nerve at posterior palatine foramen; 3, nasopalatine nerve entering anterior palatine canal; 4, needle in position for blocking the nasopalatine nerve at the anterior palatine foramen; 5, dorsum of tongue.

BLOCKING THE NASOPALATINE NERVE LINGUAL TO THE CENTRAL AND LATERAL INCISOR TEETH

If the tissue to the lingual of the upper central and lateral incisors is to be involved, as, for example, for extraction, the needle is inserted midway between the linguo-gingival margin and apex of the central incisor. The needle is now advanced upward until it strikes the linguoalveolar plate, and

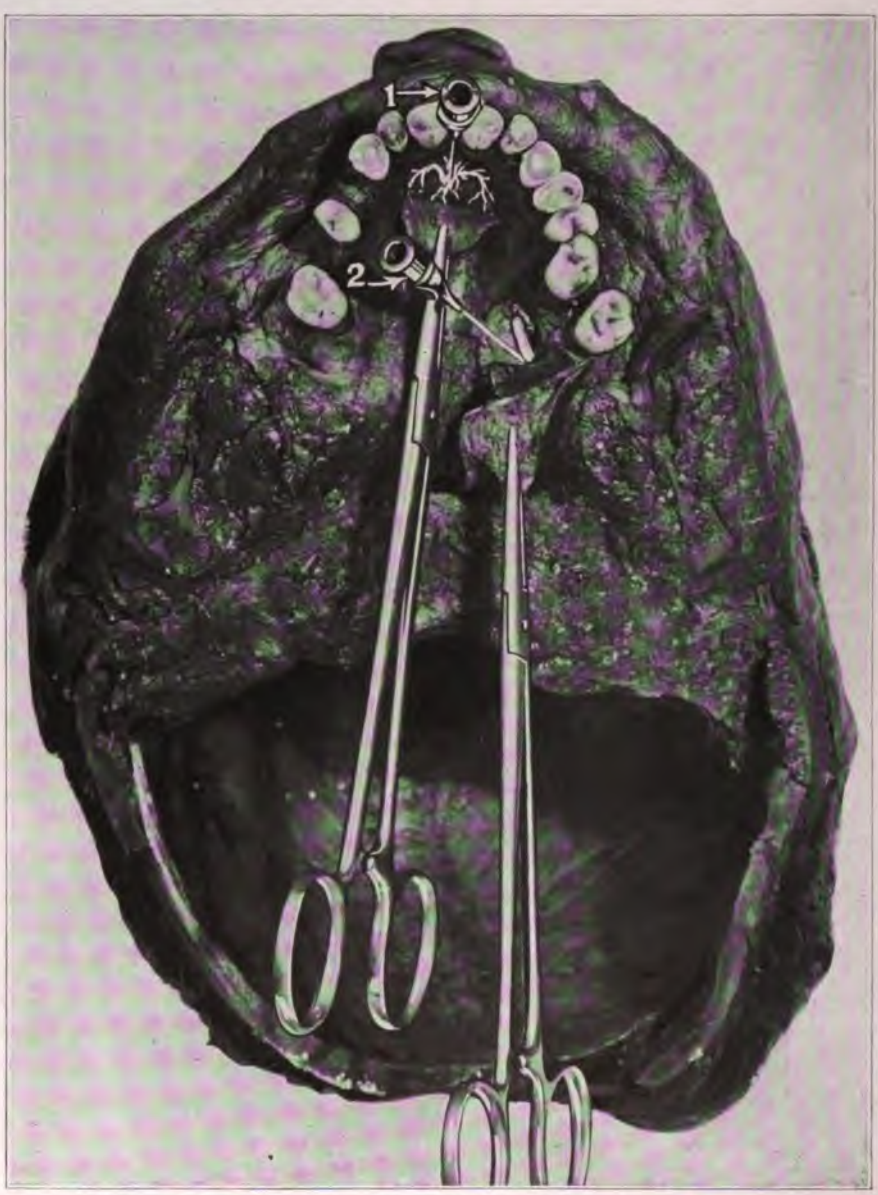


Fig. 351.—1, needle in position for blocking the nasopalatine nerves at the anterior palatine foramen; 2, needle in position for blocking the anterior palatine nerve at the posterior palatine foramen.

three minims of solution are slowly injected. The needle is now placed parallel to the linguoalveolar plate, and is advanced upward until it strikes the hard palate. (See Figs. 344 and 352.) The amount of solution injected is one-half mil, and the approximate depth of the needle is one centimeter.

BLOCKING THE NERVE SUPPLY LINGUAL TO THE CENTRAL AND LATERAL INCISORS AND CUSPID TEETH ON ONE SIDE ONLY

To block the tissue covering the linguoalveolar plate in the region of the central, lateral, and cuspid teeth, two injections must be given. Block the nasopalatine nerve at the side of the anterior palatine foramen as described on page 512; also block the terminal or overlapping branches from the anterior palatine nerve, using the following technic: The syringe is filled with one mil of solution, and needle No. 4 is inserted into the gum tissue midway between the linguo-gingival margin and the apex of the cuspid tooth, holding the syringe across the median line, as illustrated in Fig. 345. The needle is advanced upward and laterally until it reaches the linguoalveolar plate, and three minims of solution injected. Then change the needle, as illustrated in Fig. 475 until it is parallel to the linguoalveolar plate. (See Fig. 343.) Advance the needle upward until it strikes the hard palate, where one-half mil of the solution is injected. (See Fig. 344.) This injection blocks the terminal or communicating branches from the anterior palatine nerve.

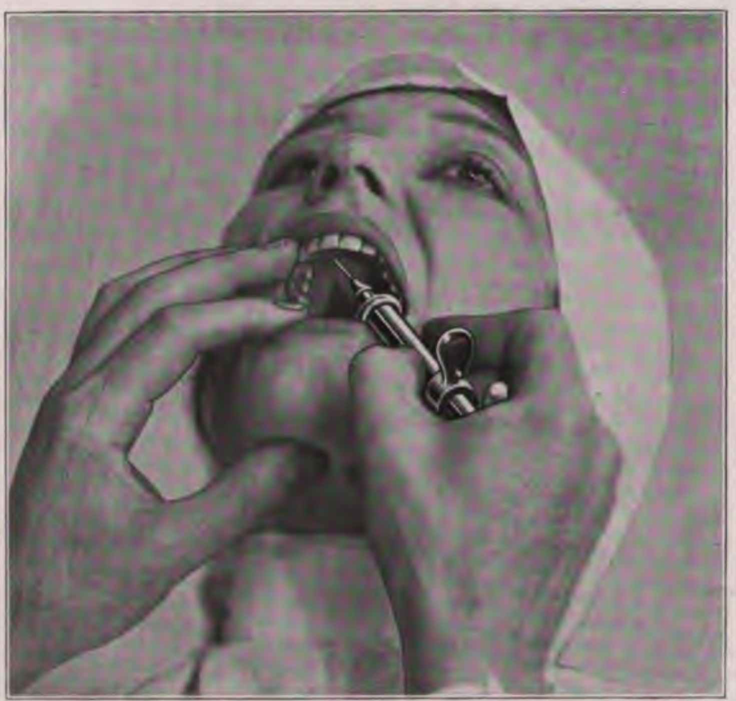


Fig. 352.—Blocking the nasopalatine nerve on one side only, lingual to central or lateral incisor teeth. (See Fig. 344.)

BLOCKING THE UPPER SIXTEEN TEETH, ALVEOLAR PROCESS, BUCCAL AND LABIAL STRUCTURES WITH FOUR INJECTIONS

The author in many cases advocates the blocking of the upper sixteen teeth, alveolar process, buccal and labial structures by two posterior superior dental injections and two intraosseous injections. These four injections are necessary to produce profound anesthesia of the upper named structures. The technic is as follows:

1-2. Blocking the Right and Left Posterior Superior Dental Nerves in Conjunction with Two Intraosseous Injections.—These nerve branches are blocked in accordance with the technic given on page 416. The two posterior superior dental injections will produce anesthesia as far anteriorly as the region of the upper first molar. Anesthesia which is produced by these two injections will meet the anesthesia produced by the two intraosseous injections, as given below, in the region of the upper first molar. (See Fig. 353.) In other words, the upper first molar is the dividing line between the posterior superior dental and intraosseous injections. Therefore, anesthesia is produced in the region of the upper first molar by both injections.

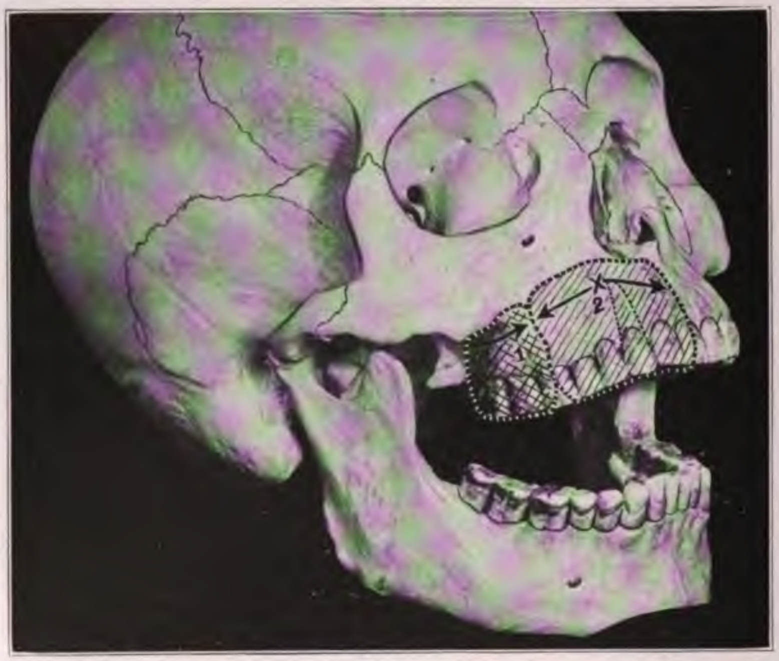


Fig. 353.—Illustrates the anesthetizing of the teeth located in one-half of the jaw, by a combined intraosseous injection and the blocking of the posterior superior dental nerve. The dotted line situated around area No. 1 represents the region that is anesthetized by blocking the posterior superior dental nerve. The area which is indicated by No. 2 represents the part that is anesthetized by injecting the solution at (x). The arrows indicate the manner in which anesthesia is secured.

3-4. Right and Left Intraosseous Injections.—The two intraosseous injections are now made, one on either side of the upper jaw. Each injection is made slightly above and distal to the apex of the cuspid tooth. The same general principles are followed here as given on page 438. The amount of solution required for each intraosseous injection is two mils. Anesthesia by the intraosseous method extends as far distally as the region occupied by the upper first molar, at which place it meets the anesthesia produced by blocking the posterior superior dental nerve. Anesthesia from the two intraosseous injections will meet at the median line. (See Fig. 354.) These four injections are all that are necessary for producing deep anesthesia of the upper sixteen teeth for such operations as pulp removal, cavity preparation, shaping the crowns for bridge abutments, or for other operations on the buccal and labial structures, which do not involve the lingual structures. If the teeth are to be extracted, or in the treatment of pyorrhea alveolaris, which involves the lingual gum tissue and periosteum, then block the anterior palatine nerves as they emerge from the posterior palatine foramina (see page 501 for technic); also block the nasopalatine nerves as they emerge from the anterior palatine foramen. (See page 512 for technic.) The blocking of the inner loop will produce anesthesia of the lingual structures, such as gum tissue, periosteum, etc.

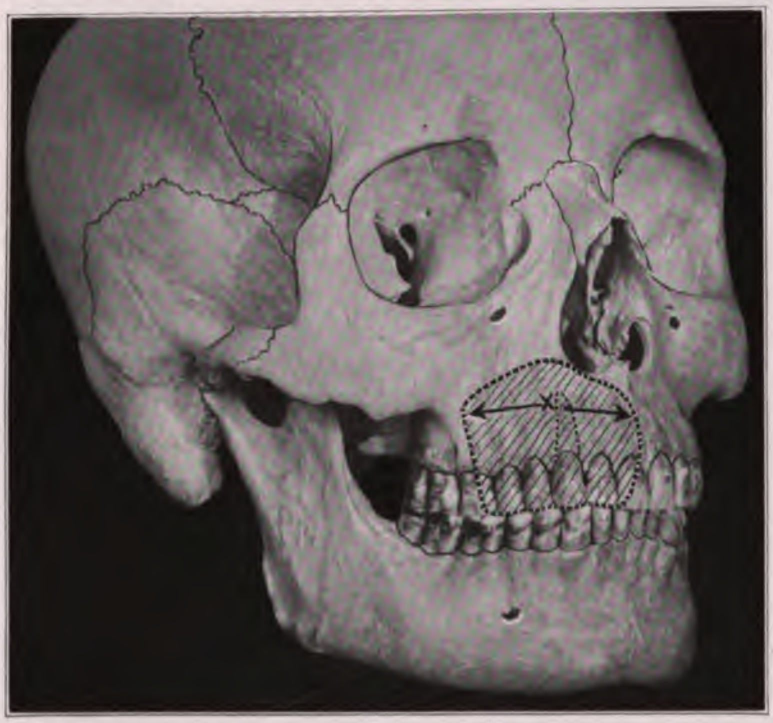


Fig. 354.—Area which is anesthetized by an intraosseous injection made distal to the apex of the cuspid tooth. The arrows indicate the passage of solution in the middle cancellous plate of process.

Total Quantity of Solution Required for Blocking the Branches of the Outer Nerve Loop by Two Deep Block and Two Intraosseous Injections

Right posterior superior dental nerve (for technic see page 416)	2 mils
Left posterior superior dental nerve (for technic see page 416)	2 mils
Right intraosseus, distally to apex of cuspid (for technic see Figs. 290 to 297)	2 mils
Left intraosseous, distally to apex of cuspid (for technic see Figs. 290 to 297)	2 mils
Total quantity for blocking outer nerve loop	8 mils

Anesthesia Produced.—Upper sixteen teeth, alveolar process, buccal and labial structures for operations not involving lingual tissues.

If the lingual tissues are involved in the operation for such cases as the extraction of teeth or the treatment of pyorrhea alveolaris, etc., then block the branches forming the inner nerve loops, using the following amount of solution:

Right anterior palatine nerve (for technic, see page 501)	½ mil
Left anterior palatine nerve (for technic, see page 501)	½ mil
Right and left nasopalatine nerves (for technic, see page 512)	½ mil
Total quantity for blocking inner nerve loop	1½ mils
Total quantity for blocking outer nerve loop	8 mils
Total quantity for blocking the outer and inner nerve loops	9½ mils

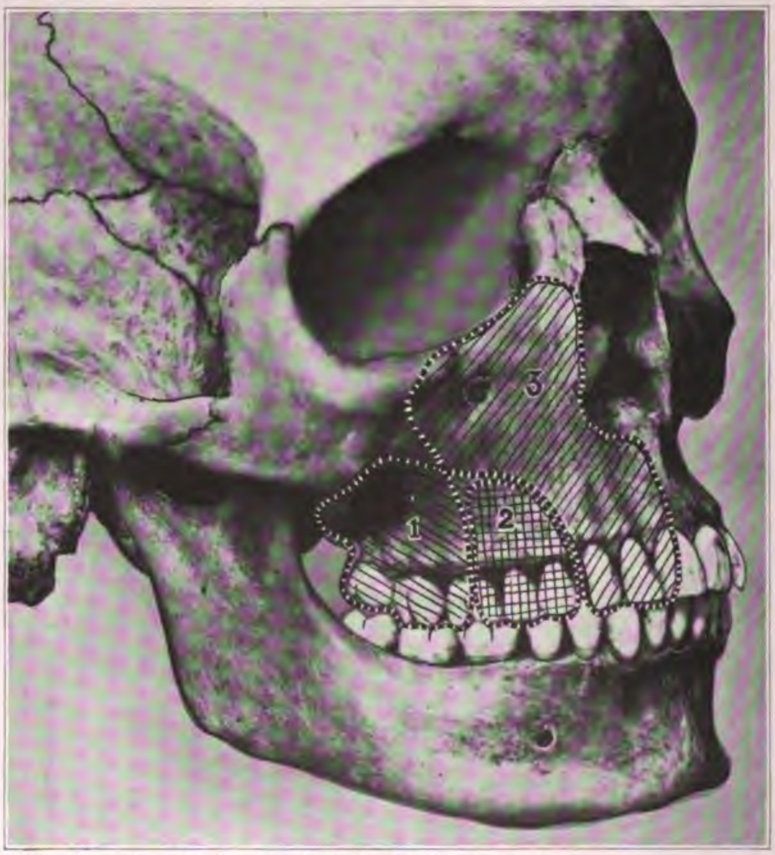


Fig. 355.—The outlines of the areas blocked by three injections.
1, Posterior superior dental injection; 2, subperiosteal infiltration injection; 3, infraorbital injection.

AMOUNT OF SOLUTION REQUIRED FOR BLOCKING THE UPPER SIXTEEN TEETH, ALVEOLAR PROCESS, BUCCAL, LABIAL, AND LINGUAL STRUCTURES BY THE DEEP BLOCK AND SUBPERIOSTEAL INFILTRATION METHODS

Right and Left Outer Nerve Loops	Right posterior superior dental nerve (deep block) (for technic see page 416).... Left posterior superior dental nerve (deep block) (for technic see page 416)....	2 mils 2 mils	For zone 3	Anesthesia produced in upper second and third molars, alveolar process and buccal tissues.
	Right middle superior dental nerve (subperiosteal) (for technic see page 430).... Left middle superior dental nerve (subperiosteal) (for technic see page 430)....	2 mils 2 mils	For zone 2	Anesthesia produced in upper first and second bicuspids, first molar, alveolar process and buccal tissues.
	Infraorbital: Right anterior superior dental nerve (deep block) (for technic see page 459).... Left anterior superior dental nerve (deep block) (for technic see page 459)....	 2 mils 2 mils	For zone 1	Anesthesia produced in upper central, lateral and cuspid teeth, alveolar process and labial tissues.
	Total amount of solution required for blocking the outer nerve loops by this method,	12 mils		

If the lingual tissues are to be involved, as, for extraction of teeth, etc., then the inner nerve loops must be blocked by using the following quantity of solution:

Right and Left Inner Nerve Loops	Right anterior palatine nerve (deep block) (for technic see page 501)...... Left anterior palatine nerve (deep block) (for technic see page 501)......	½ mil ½ mil	Anesthesia is produced in periosteum and gum tissue lingual to upper bicuspids and molars extending to lingual surface of cuspid and near median line in hard palate.
	Right and left nasopalatine nerves (deep block) (for technic see page 512)..	½ mil	Anesthesia is produced in periosteum and gum tissue lingual to upper centrals and laterals and as far distally as the lingual surface of the cuspid.
	Total quantity solution required for blocking right and left inner nerve loops	1½ mils	
	Total quantity of solution required for blocking the outer nerve loop........	12 mils	
	Total quantity of solution required for blocking outer and inner nerve loops by this method	13½ mils	
	Amount of solution required to block the outer and inner nerve loops by the combined deep block and intraosseous method (see page 522)........	9½ mils	
	Difference in amount of solution required by the two methods.............. Amount of solution required to block the right and left second divisions, which include the outer and inner nerve loops (see page 524)......	4 mils 8 mils	Anesthesia secured in upper 16 teeth, antrum, alveolar process, buccal, labial, and lingual tissues.

BLOCKING THE UPPER JAW BY A RIGHT AND LEFT SECOND DIVISION INJECTION BY INTRAORAL METHOD

The right and left second division injections produce anesthesia of the upper jaw for such operations as the extraction of the upper sixteen teeth, alveolectomy, antrum operations, removal of tumors, cavity preparation, pulp removal—in fact, every kind of a surgical operation which involves those tissues supplied by the second division of the fifth nerve. Each injection blocks both the outer and inner nerve loops, the infraorbital nerve and its terminal branches. The amount of solution required is as follows:

Right second division of fifth nerve (deep block) (for technic see page 380)	4 mils
Left second division of fifth nerve (deep block) (for technic see page 380)	4 mils
Total quantity of solution required for blocking the right and left second division of fifth nerve by intraoral method	8 mils

It will be noted that blocking by this method requires less solution than by the other methods given on pages 522 and 523.

CHAPTER XXVI

TECHNIC FOR BLOCKING THE THIRD OR MANDIBULAR DIVISION OF FIFTH NERVE AND ITS BRANCHES

BLOCKING THE MANDIBULAR OR THIRD DIVISION OF THE FIFTH CRANIAL NERVE (EXTRAORAL)

Topography of Anatomy.—The reader is referred to Chapter VII for a detailed description of the anatomy of the nervus mandibularis. However, it is necessary to state briefly the most important facts with reference to this nerve trunk and the osteology. This nerve branch is the largest of the three divisions of the fifth cranial nerve (see Figs. 48 and 51), and as it passes through the foramen ovale (see Fig. 34) it assumes the shape of the foramen and varies in width from seven to twelve millimeters. (See Figs. 40, 48, 52, 53 and 60.)

The foramen ovale is located in the greater wing of the sphenoid bone and opens downward and forward. It is of a large size and elongated form, giving passage to the mandibular or third division of the trigeminal nerve, and admits the accessory meningeal branch of the middle meningeal artery. (See Fig. 61.)

After this large nerve passes out of the cranial cavity through the foramen ovale it enters the infratemporal fossa and passes forward, downward, and slightly laterally, medial to the external pterygoid muscle. (See Figs. 49, 64 and 67.)

After this nerve passes through the foramen ovale it continues forward for an approximate distance of one and a half centimeters before it takes a downward and lateral course.

TECHNIC FOR BLOCKING THE THIRD OR MANDIBULAR DIVISION OF FIFTH NERVE BY EXTRAORAL METHOD

Needles Employed.—Two needles are employed for blocking the third division by the extraoral route. Needle No. 7, 10 millimeters in length, and 27 gauge, is first used to make the preliminary injection into the skin, at the point marked *x* in Fig. 357. Needle No. 8, 60 mm. in length, and 20 gauge is employed for the final injection. (See Fig. 177.)

Technic of Injection.—First, locate the sigmoid notch, which is situated below the zygoma and the upper portion of the ascending ramus between the coronoid process and the condyle (see Fig. 33), by placing the tip of the index finger on the skin exterior to this region. With the index finger in position, as illustrated in Fig. 356, have the patient open and close the mouth, which will greatly assist in locating the sigmoid notch. However, if it is impossible for the patient to open and close his mouth without experiencing pain, the operator then relies on pressure alone to locate this region. In most cases the sigmoid notch is easy to locate by first palpating the condyle, coronoid process, the lower border of the zygomatic arch, and the upper part of the ramus which forms the lower border of the sigmoid notch. When pressure is exerted upon the skin directly over the region of the sigmoid notch, a depression is observed.

After the sigmoid notch is located, then draw a line parallel to the lower border of the zygomatic arch, which should extend from the anterior or free border of the condyle to the coronoid process of the mandible. Another line is drawn which outlines the upper border of the ramus along the lower border of the sigmoid notch. This curved line joins the horizontal line, which has been drawn parallel to the lower surface of the zygomatic arch. If this is done correctly, the two lines will form a semicircle. (See Fig. 357.) These lines can be made by a dermographic pencil or with iodin. The initial puncture of the skin is at the center of the semicircle indicated by X in Fig. 357.

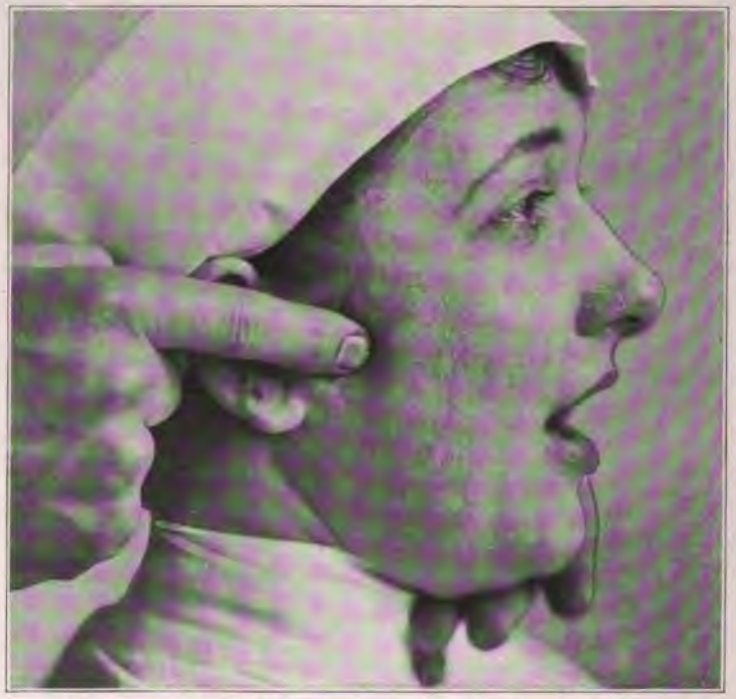


Fig. 356.—Locating the sigmoid notch with tip of index finger.

Now with the landmarks correctly outlined, the next step is to prepare the skin over the region, by scrubbing with soap and water, followed by 1/1000 bichloride solution or tincture of iodin. With the skin properly prepared, make a preliminary injection using one mil of solution. Fig. 358 shows the preliminary needle in the skin. The skin is grasped between the index finger and thumb, the sharp needle is carefully inserted beneath the surface of the skin, and 5 minims of the solution injected. After waiting one half minute the needle is gradually advanced into the skin and subcutaneous tissue, injecting slowly until one mil of the solution has been injected. It must be remembered that the skin and connective tissue are extremely sensitive and the preliminary injection will, in most cases, eliminate all pain which would be caused with the regular nerve blocking needle, in case no preliminary injection was made.

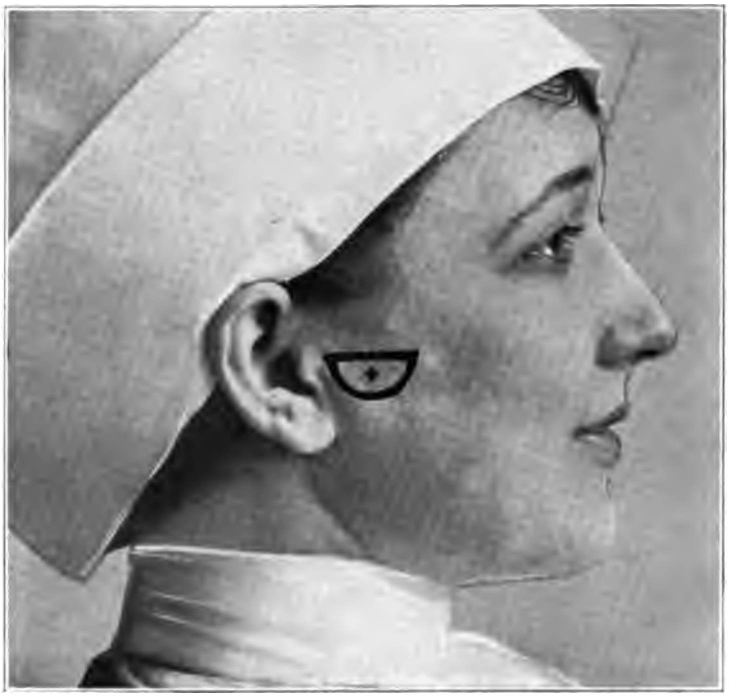


Fig. 357.—Outline showing the sigmoid notch. Straight line is parallel to lower surface of zygomatic process. Curved line outlines the upper portion of ascending ramus. *X* indicates starting point of needle.

After the elapse of three minutes, needle No. 8, which is 60 mm. in length, is used. The skin is punctured with the needle in the center of the semicircle, and is advanced directly inward at right angles to the surface of the skin. (See Fig. 359.) The needle is advanced through the skin, connective tissue, and masseter muscle, the operator being very careful to hold the long axis of the syringe and needle at right angles to the surface of the skin. While advancing the needle, if there is the least resistance shown by the patient, it is good practice to inject continuously from the time the needle is inserted into the skin until the region of the third division is reached. In most cases it will be found that, if the skin and connective tissue have been properly anesthetized by the preliminary injection, there will be little or no pain experienced while inserting the needle to the proper depth.

Too much emphasis cannot be placed on the necessity of advancing the needle into the tissues at right angles to the surface of the skin. This will be found much easier than to advance the needle inward at any other angle. (See Figs. 360, 361 and 362.) By advancing the needle inward at right angles to the surface of the skin, the third or mandibular division is reached at a point approximately one centimeter anterior-inferior to the foramen ovale. So far as practical purposes are concerned, it makes no difference whether the solution is injected into the nerve trunk as it emerges from the foramen, or is injected at a point one centimeter anterior-inferior to the foramen ovale. The same nerve branch is blocked, and the object of blocking it anterior to the foramen is that it makes the technic much easier by inserting the needle at right angles to the skin surface than to carry the needle backwards at an acute angle with the skin surface. (See Figs. 363 and 364.) If this technic is employed, the operator will find it much easier and will meet with fewer failures than if he attempted to locate the foramen ovale, which would necessitate inserting the needle backward at an acute angle to the skin.

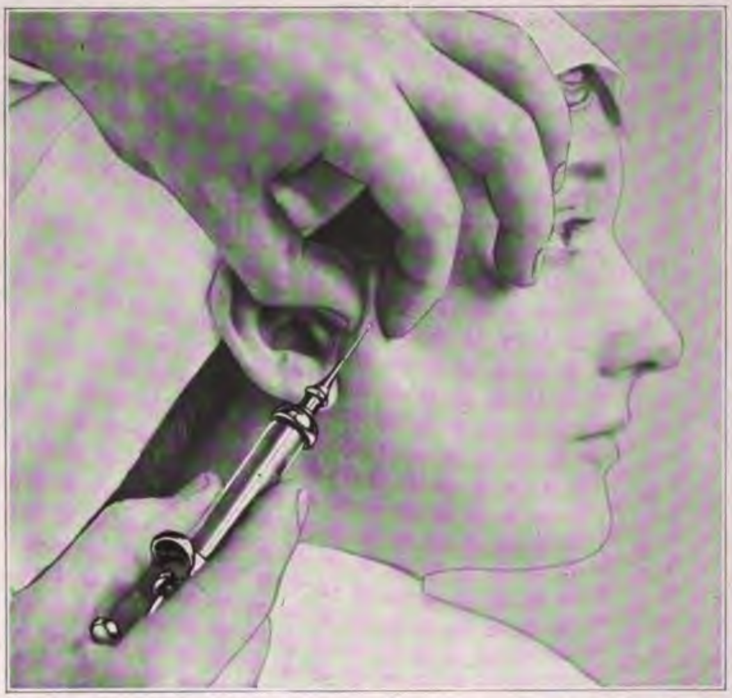


Fig. 358.—Preliminary injection into the skin prior to inserting needle for blocking the third or mandibular division.

Injection of Solution.—The amount of solution required for the preliminary injection into the skin and connective tissue is one mil. Three minutes should elapse following the preliminary injection before the regular nerve blocking needle is employed. The hypodermic syringe is filled with four mils of the solution. The amount injected while the needle is being avanced through the tissue, is one mil, while the remaining amount, which is three mils, is injected into the region of the third or mandibular division.

Precautions.—The precautions that should be taken in the execution of the technic for blocking the third or mandibular nerve trunk are as follows: Care should be taken in outlining the bony landmarks, which enclose the region of the sigmoid notch. If this is not done correctly, the needle may not be inserted at the proper location. In case of an infection or extreme inflammation, the opening of the mouth may cause considerable pain to the patient, then the operator must exercise care in locating the region of the sigmoid notch by palpation. Always inject one mil of solution into the skin and subcutaneous connective tissue to eliminate the pain produced by the regular nerve blocking needle. The needle should be advanced into the region of the nerve trunk at a right angle to the surface of the skin. The average depth to which the needle is inserted is four centimeters. However, the depth of the needle depends upon the size of the patient's head, thickness of the skin, connective and adipose tissues through which the needle must pass.

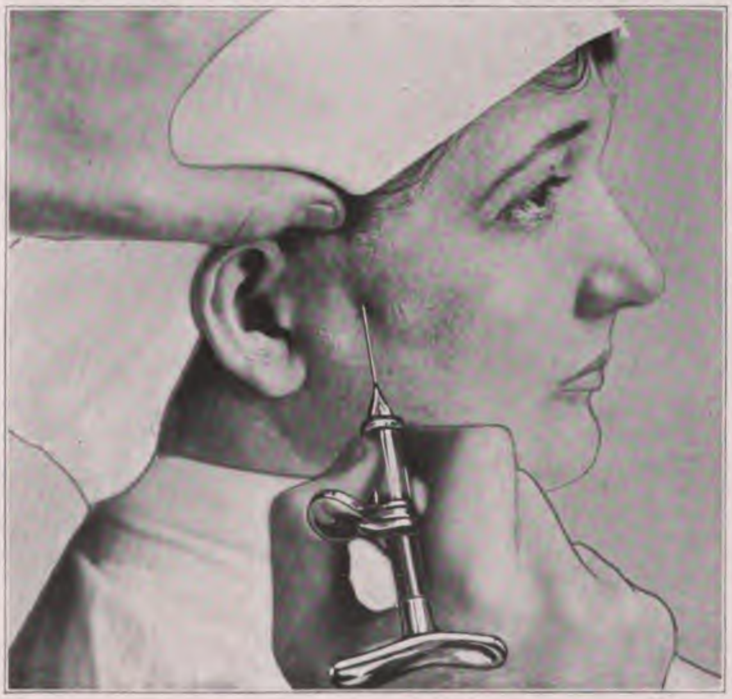


Fig. 359.—Starting the needle for blocking the third or mandibular division.

Time to Wait for Anesthesia.—The time to wait for anesthesia will vary from fifteen to twenty-five minutes. It must be remembered that the diameter of this nerve at the point of blocking will vary from 7 to 12 mm., and is surrounded by connective tissue and epineurium, and a sufficient length of time must elapse, after the solution is deposited, to allow it to permeate the epineurium and the nerve fibers. The rules governing the time for anesthesia depend upon the four factors given on page 196. The efforts of many operators have failed with this injection, because they attempted to operate before allowing the anesthetic solution time to thoroughly permeate the nerve and produce profound anesthesia.

Structures Anesthetized.—Anesthesia is produced in all nerve branches arising from the third division anterior to the point of injection. The principal branches anesthetized include the inferior dental, lingual, auriculo-temporal, and long buccal. The tissues anesthetized are the greater part of the lower jaw, the teeth on the corresponding side as far anteriorly as the cuspid, the buccal periosteum, gum tissue and mucosa, a portion of the cheek and skin, the mucosa located in the floor of the mouth, anterior two-thirds of the tongue, lingual gum tissue, and periosteum.

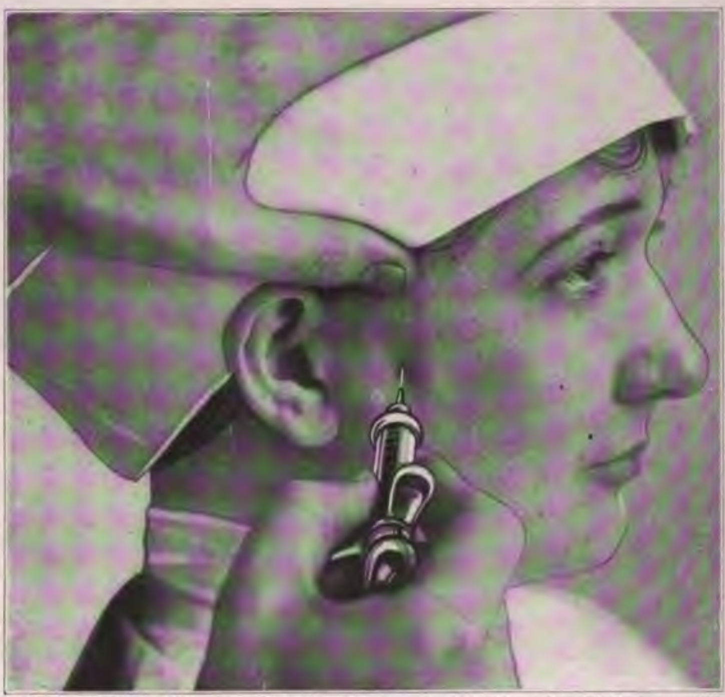


Fig. 360.—Needle in position while injecting the solution for blocking the third or mandibular division.

Blocking the Interlacing or Overlapping Branches.—If it is desired to block the entire lower jaw, the third or mandibular division is blocked on the opposite side. The nerve branches on the right and left sides overlap in the region of median line. If the operation extends near the median line, it is then necessary to block the terminal branches from the opposite side at the mental foramen, and on the lingual side of this region, or block the inferior dentolingual. In case the third or mandibular division is blocked for a major oral operation involving the lower border of the mandible, it is necessary to block the cervical plexus, either at the posterior margin of the sternocleidomastoid muscle (see Figs. 532 and 533) or anesthetize the terminal branches of the cervical plexus along the lower border of the mandible by the regional method. (See Fig. 408.)

Indications for Blocking the Third or Mandibular Division by the Extraoral Method.—The extraoral method of blocking the third or mandibular division of the fifth cranial nerve is of great advantage in operating for such pathological conditions as fractures, gunshot wounds, cysts, impacted third molars, or for any other case where infection is present within the oral cavity. These injections proved of inestimable value in the recent war. Many of the wounded soldiers, who sustained facial and jaw injuries, were blocked, which eliminated postoperative complications, such as nausea, and pneumonia occurring from ether or chloroform.

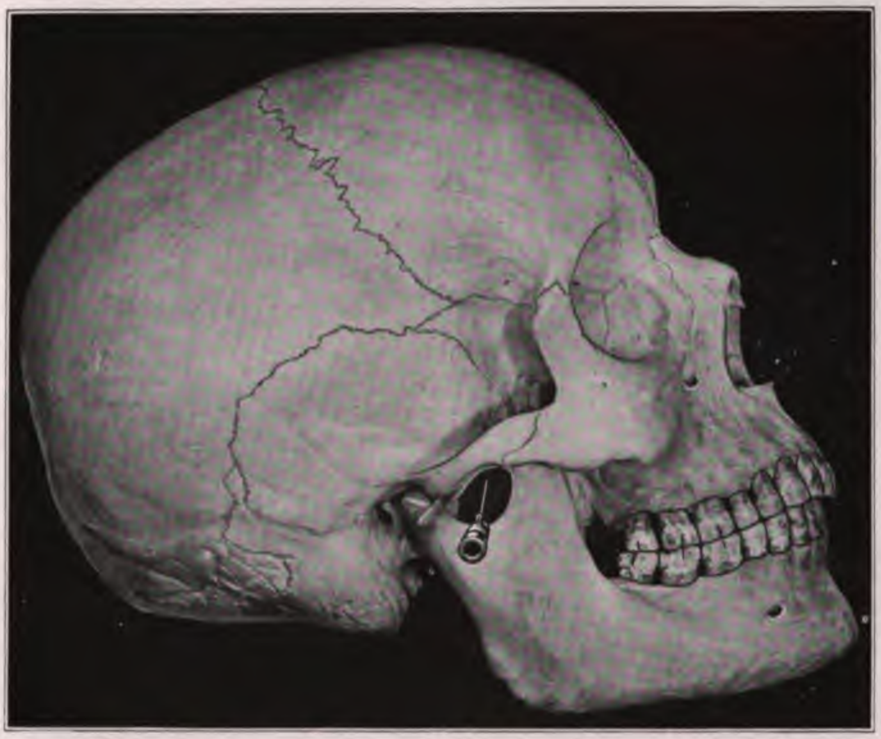


Fig. 361.—Position of needle while injecting the solution near the foramen ovale for blocking the third or mandibular division.

BLOCKING THE INFERIOR DENTO-LINGUAL NERVES BY THE INTRAORAL METHOD

Topography of Anatomy.—The reader is referred to Chapter VII for a detailed description of the inferior dental and lingual nerve branches. At this time a summary will be given.

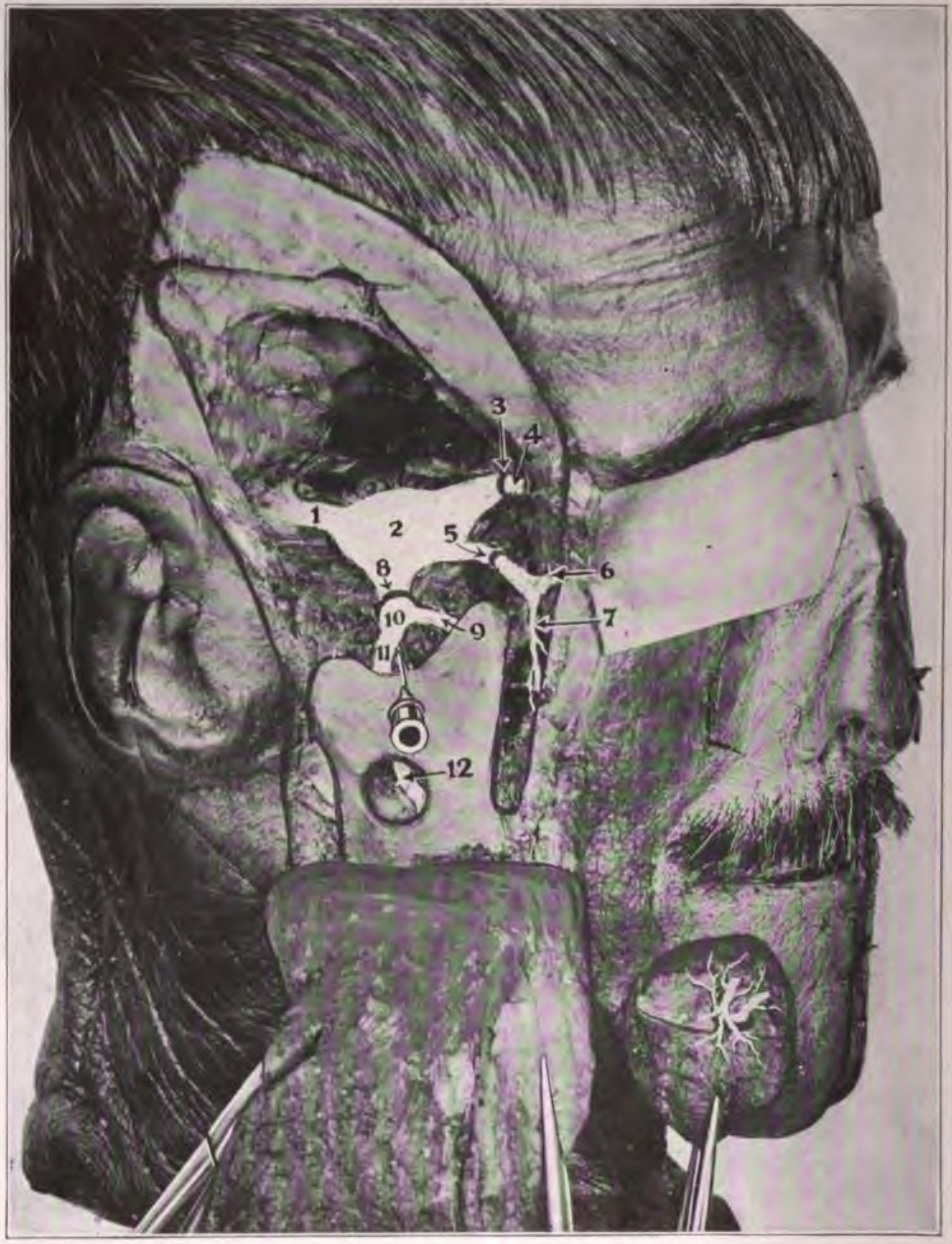


Fig. 362.—Needle inserted through sigmoid notch and in region of third or mandibular division.

1, Sensory root of trigeminal nerve; 2, semilunar (Gasserian) ganglion; 3, superior orbital (sphenoidal) fissure; 4, ophthalmic division of trigeminal nerve; 5, foramen rotundum; 6, infraorbital nerve; 7, posterior superior dental nerve; 8, foramen ovale; 9, long buccal nerve; 10, mandibular nerve; 11 and 12, inferior dental nerve.

The inferior dental and lingual nerves are derived from the third or mandibular division and are its terminal branches. In most cases the inferior dental is slightly larger than the lingual nerve. However, the author has found the lingual nerve to be the larger in two of the specimens which he has dissected.

The inferior dental nerve emerges from beneath the inferior border of the external pterygoid muscle and passes downward and anteriorly to the pterygo-mandibular region, located between the inner aspect of the ascending ramus, and the lateral aspect of the sphenomandibular ligament and the internal pterygoid muscle. (See Figs. 48, 65, 67, 88, 120, 125, and 368.) After the inferior dental arises from the third or mandibular division its direction is forward, downward and lateral. (See Figs. 67-95 and 96.) This nerve enters the opening of the inferior dental canal, (see Fig. 105) which is situated approximately 2 cm. beneath the lower part of the sigmoid notch and midway between the posterior and anterior border of the ascending ramus of the mandible. (See Figs. 94 and 104.) A spicule of bone is located

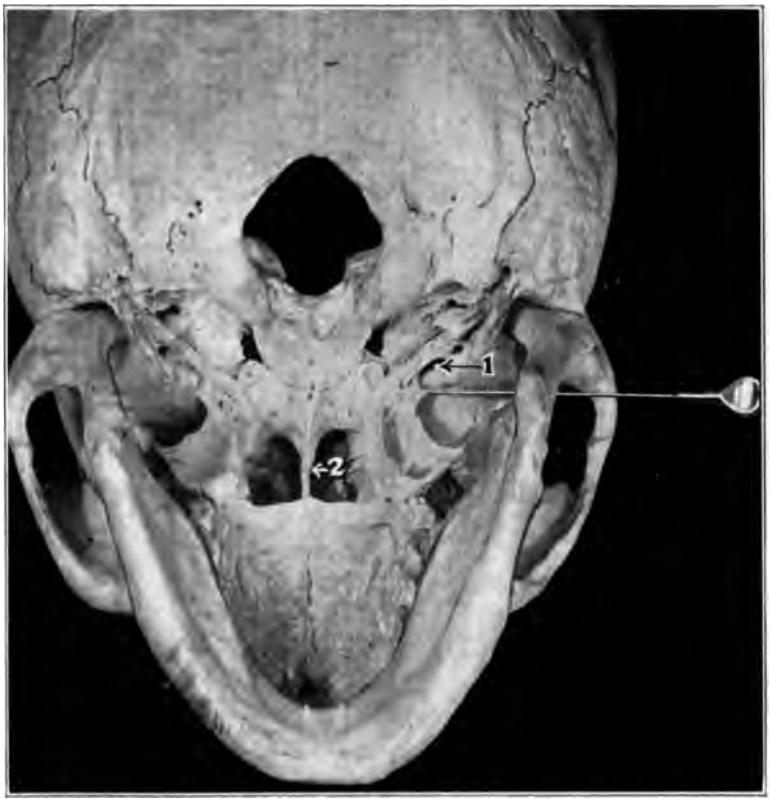


Fig 365.—Needle point 1 cm. anterior and inferior to foramen ovale for blocking third or mandibular division.
1, Foramen ovale; 2, posterior part of nasal septum.

anterior to the beginning of the inferior dental canal (see Fig. 103). The inferior dental nerve passes downward and forward in the canal, giving off small branches supplying the teeth, alveolar process, a portion of the lower jaw bone, buccal periosteum, gum tissue, and a portion of the mucous membrane of the cheek (see Fig. 69). It divides into the incisive and mental branches, when it reaches the region of the mental foramen. The incisive nerve continues in the inferior dental canal supplying the cuspid, lateral, and central incisors. The mental nerve emerges from the body of the mandible through the mental foramen, dividing into the anterior and posterior rami. These two branches supply the lingual structures in the region of the bicuspid teeth; also the buccal mucosa and a portion of the cheek (see Figs. 107 and 111.)

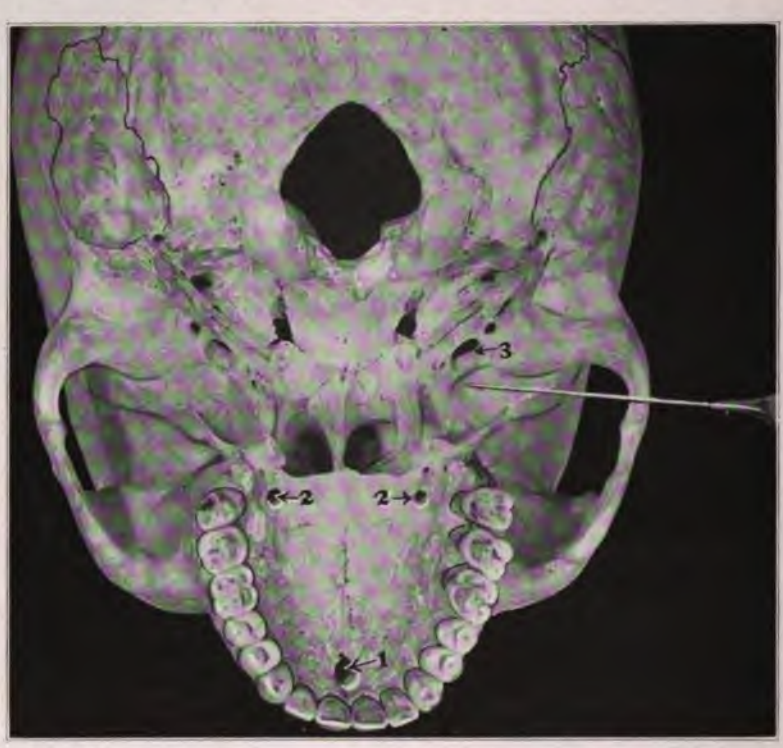


Fig. 364.—Relation of needle to foramen ovale, sphenoid bone, and zygomatic process for blocking the third or mandibular division.
1, Anterior palatine foramen; 2, posterior palatine foramina; 3, foramen ovale.

As has been stated, the lingual nerve is a branch of the third or mandibular division. It passes downward, forward and laterally (see Figs. 42, 67, 125 and 367) and is situated anterior to the inferior dental nerve; as it passes in the direction given, the two nerves separate. The lingual nerve enters the pterygomandibular region on a level of 1 cm. above the occlusal plane of the lower teeth. It is located approximately 1 cm. anterior and medial to the inferior dental nerve. (See Fig. 125.) This level is shown on cross section at a point 2 or 3 mm. above the opening of the inferior dental canal in Fig. 105.

The lingual nerve at this level is located 5 to 7 mm. medial and slightly posterior to the inner oblique line of the ascending ramus. The direction of this nerve, after it leaves this level, is downward, anteriorly, and slightly lateral (see Fig. 88) until it reaches the inner plate of the alveolar process, lingual

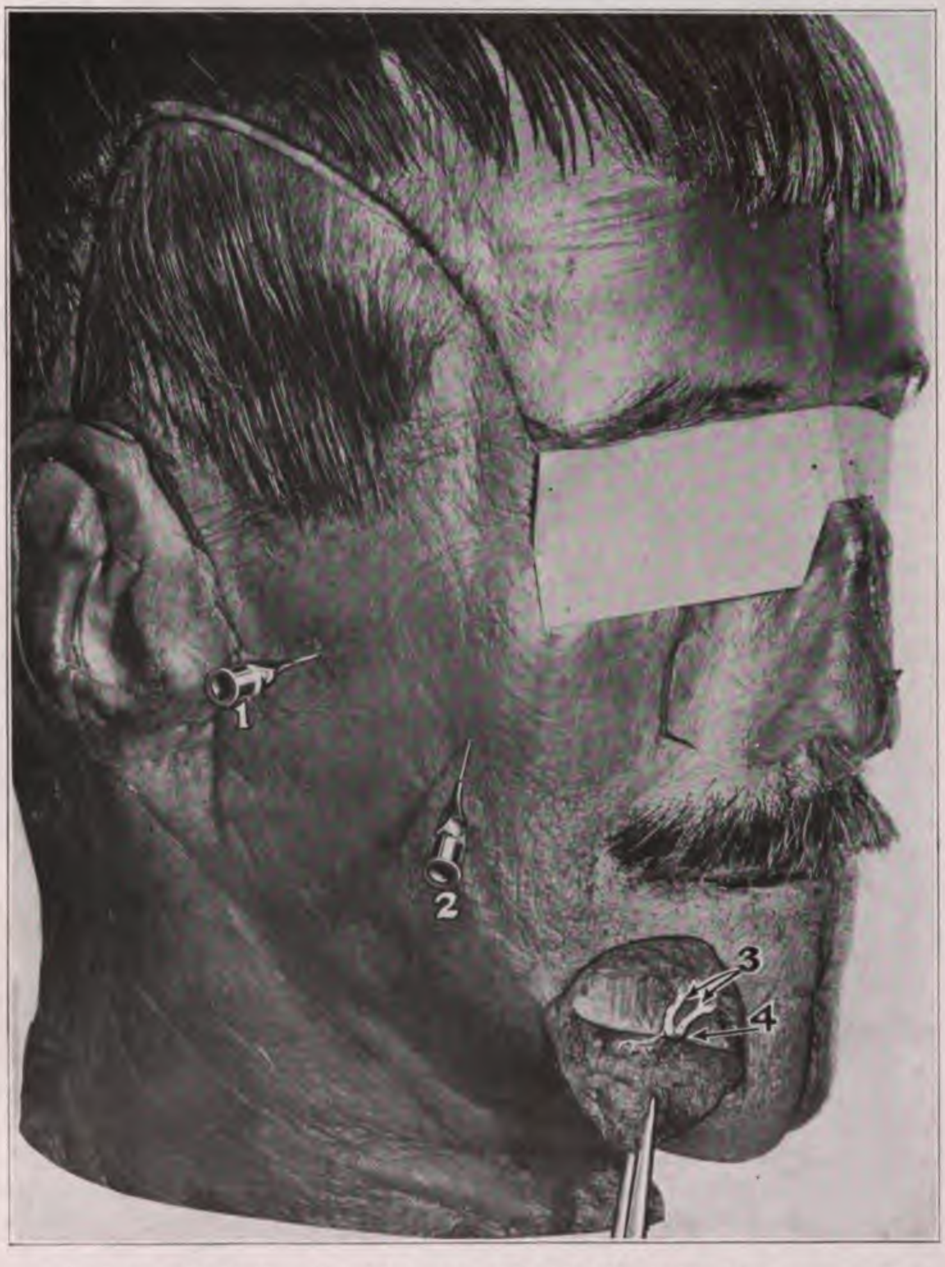


Fig. 365.—1, Needle in position for blocking the third division of the fifth nerve, (extraoral); 2, needle in position for blocking the second division of the fifth nerve, (extraoral); 3, mental nerve; 4, mental foramen.

to the lower third molar (see Figs. 94 and 106). During the author's dissections he has found this nerve in several cases to be in contact with the periosteum covering the region of the apical third of the lower third molar. Care should be exercised not to injure the nerve while operating for the removal of an impacted third molar, especially if the tooth is lingually inclined (see Fig. 94). From this point the nerve courses forward beneath the mucous membrane of the floor of the mouth in the interval between the hyoglossus and mylohyoid muscles, and beneath the duct of the submaxillary gland. (See Figs. 99 and 100.) It follows a course almost parallel to the inner lingual

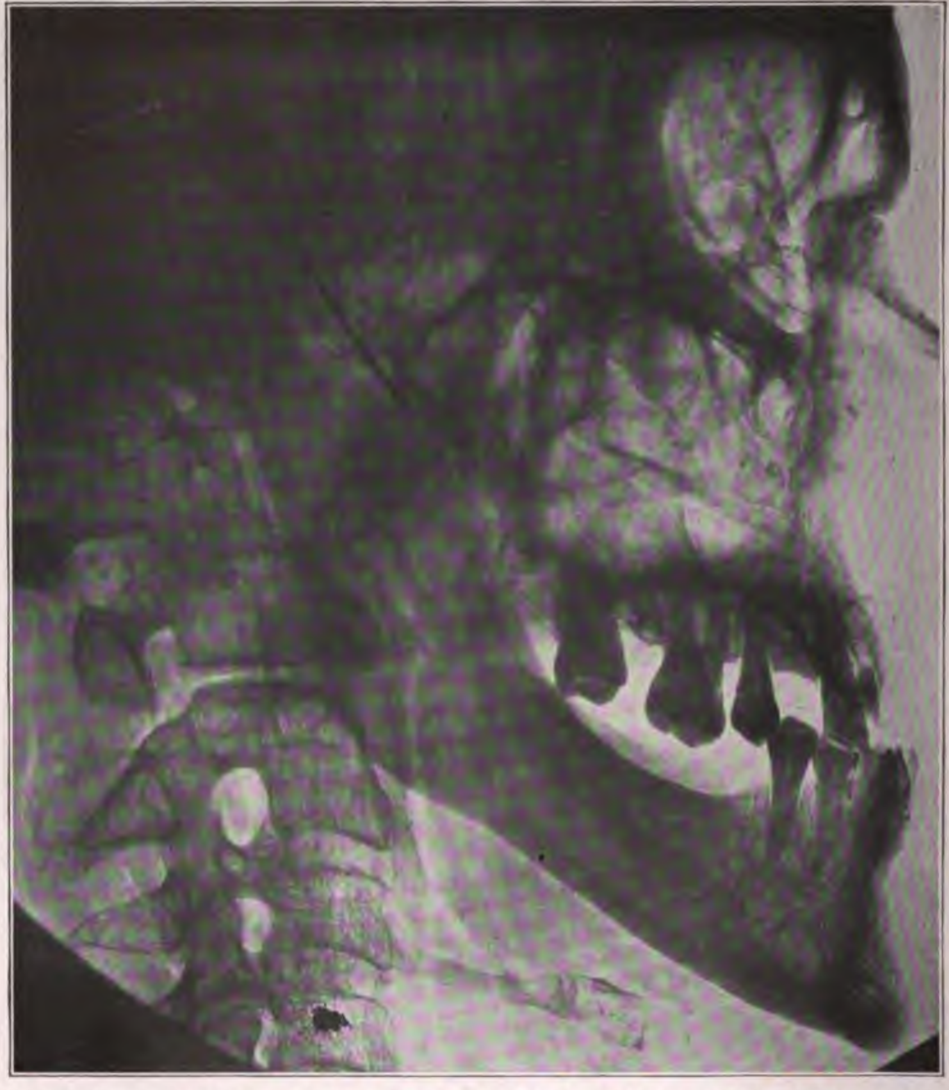


Fig. 356.—X-ray illustrating needle in position for blocking the third or mandibular division by extra-oral method.

plate of bone covering the lower second and third molars. Reaching the region mesial to the lower first molar, it courses across the floor of the mouth to the side of the tongue (see Figs. 99 and 100), where it divides into other branches which continue anteriorly along the lingual gum tissue and periosteum in the region of the teeth anterior to the first molar. The lingual branches cross the floor of the mouth supplying the anterior two-thirds of the tongue. (See Figs. 60 and 101.)

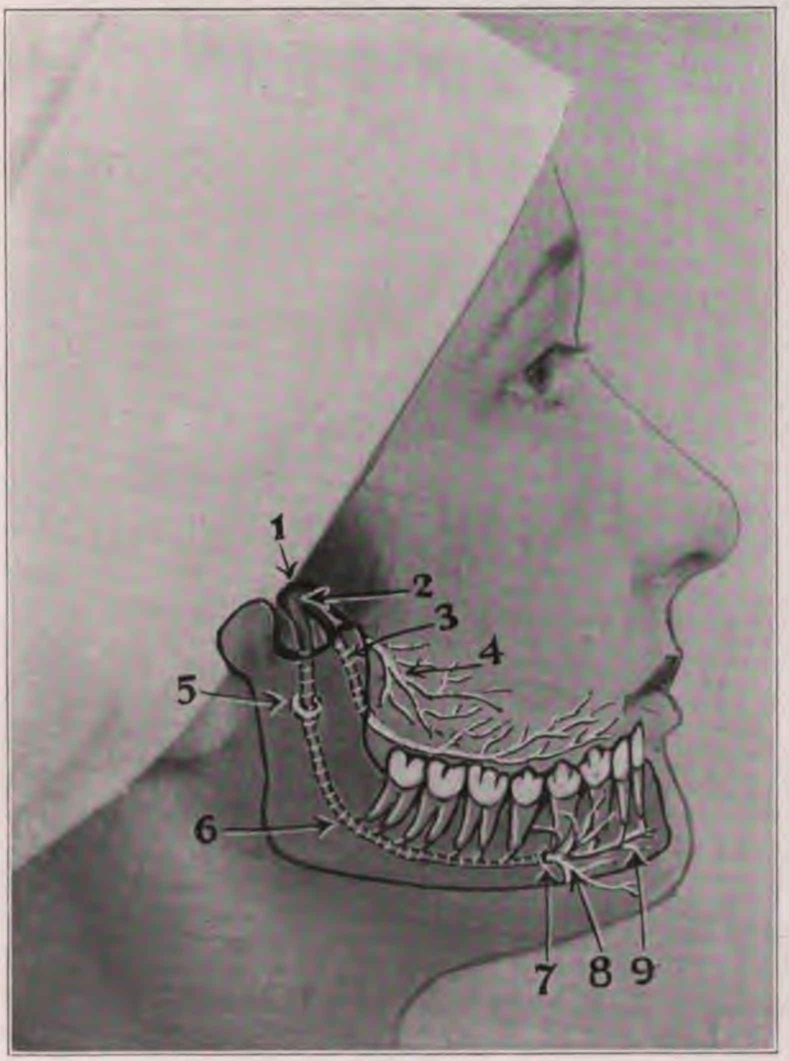


Fig. 367.—Illustrating the outline of mandible and nerve supply.
1, Foramen ovale; 2, mandibular nerve; 3, lingual nerve; 4, long buccal; 5, inferior dental foramen; 6, inferior dental nerve; 7, mental foramen; 8, mental nerves and 9, incisive nerves.

Needle Employed.—The needle employed for blocking the inferior dento-lingual nerves is No. 2, 23 gauge, and 30 mm. in length (see Fig. 177). A to the lower third molar (see Figs. 94 and 106). During the author's dissections he has found this nerve in several cases to be in contact with the periosteum covering the region of the apical third of the lower third molar. Care should be exercised not to injure the nerve while operating for the removal of an impacted third molar, especially if the tooth is lingually inclined (see Fig. 94). From this point the nerve courses forward beneath the mucous membrane of the floor of the mouth in the interval between the hyoglossus and mylohyoid muscles, and beneath the duct of the submaxillary gland. (See Figs. 99 and 100.) It follows a course almost parallel to the inner lingual

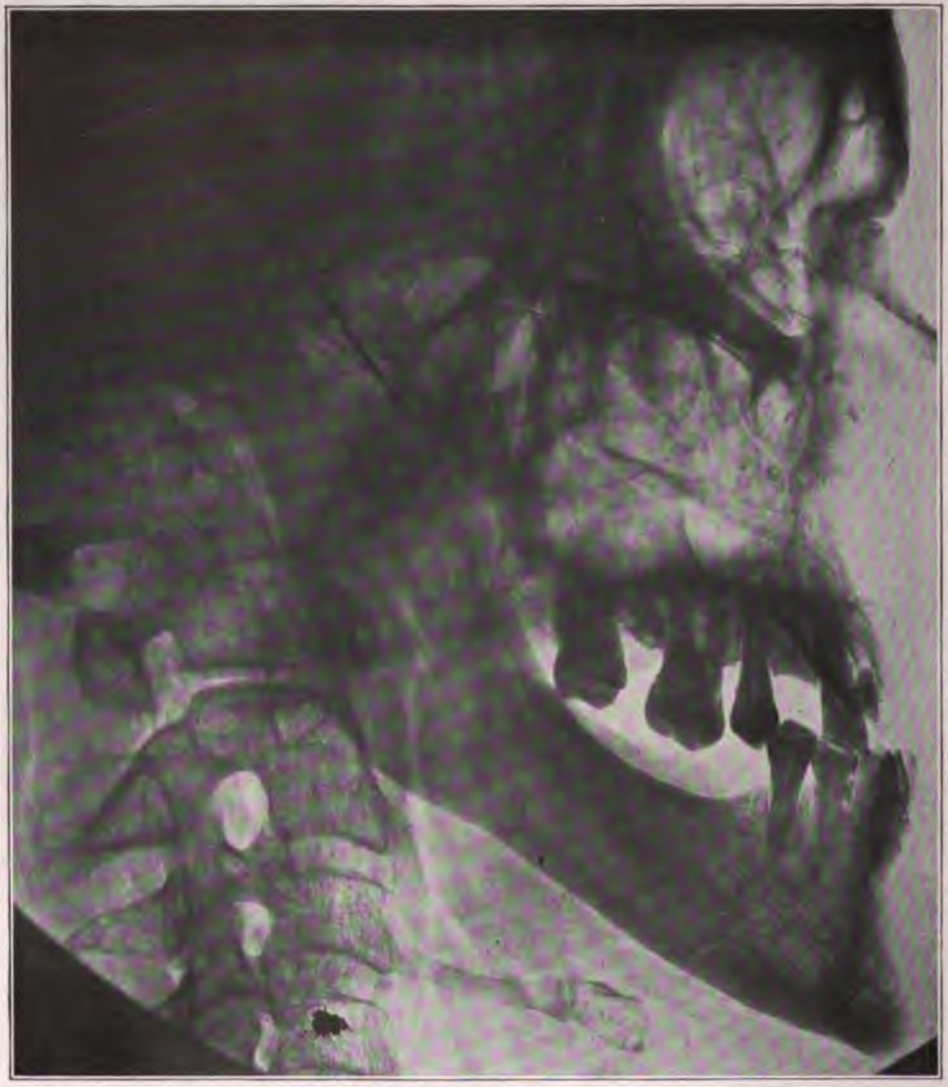


Fig. 356.—X-ray illustrating needle in position for blocking the third or mandibular division by extra-oral method.

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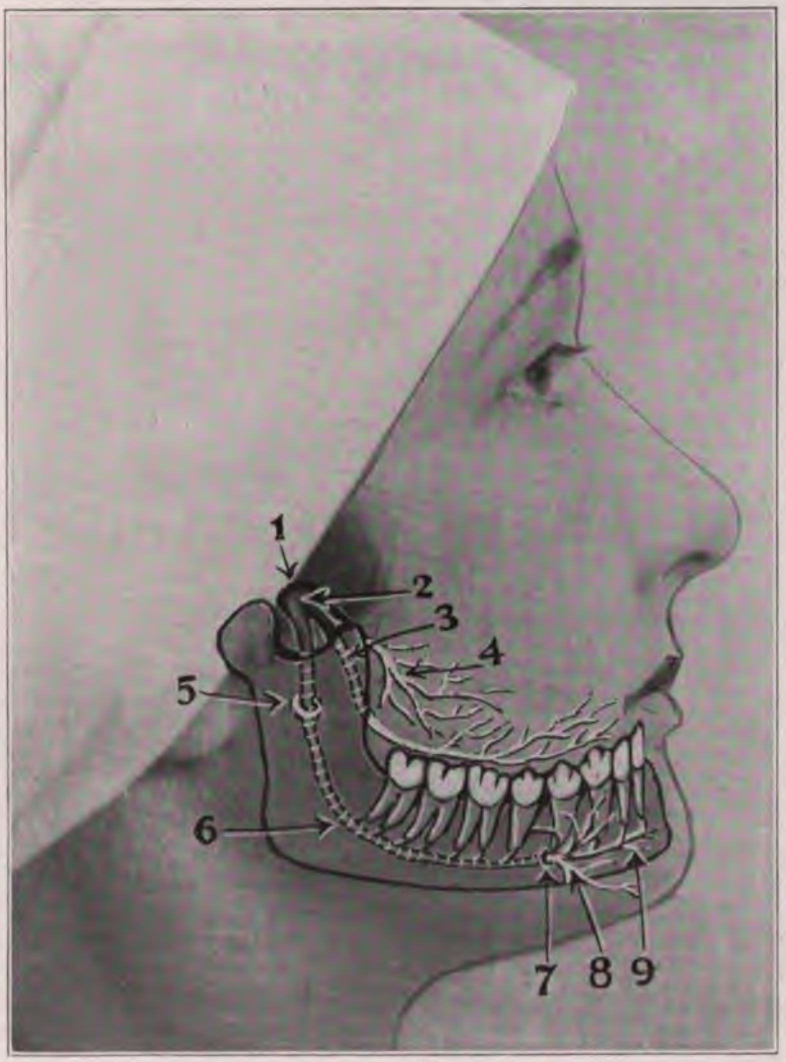

Fig. 367.—Illustrating the outline of mandible and nerve supply.
1, Foramen ovale; 2, mandibular nerve; 3, lingual nerve; 4, long buccal; 5, inferior dental foramen; 6, inferior dental nerve; 7, mental foramen; 8, mental nerves and 9, incisive nerves.

Needle Employed.—The needle employed for blocking the inferior dento-lingual nerves is No. 2, 23 gauge, and 30 mm. in length (see Fig. 177). A needle less than 23 gauge is easily bent or broken for this injection. When all factors are carefully considered, a straight, 23 gauge needle is best adapted to this injection. It is in some cases difficult to detect the periosteum in the region of the inferior dental foramen with a smaller needle. A fine needle is very easily bent in the tissue, and if this occurs, the solution may not be injected near the nerve branch. This may result in partial anesthesia or failure, or the solution may be injected into the sphenomaxillary ligament or the internal pterygoid muscle which will cause postoperative pain.

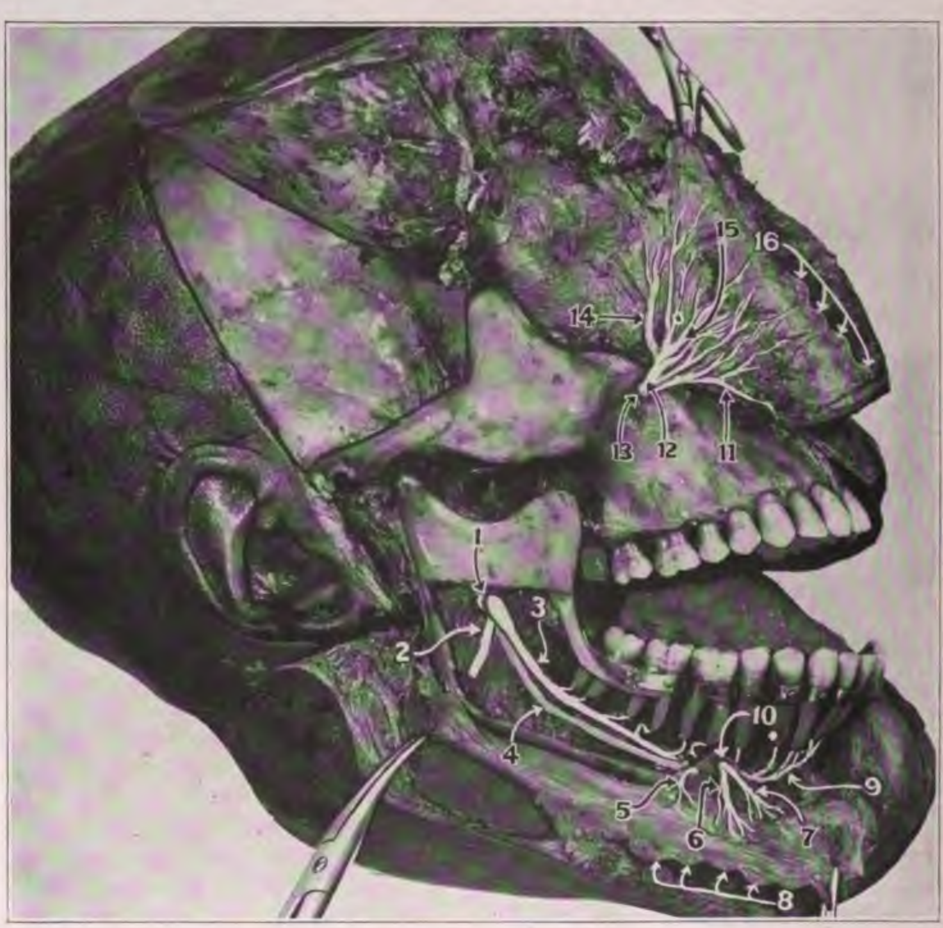

Fig. 368.—Dissected wet anatomic specimen showing the following structures:

1, Inferior dental foramen; 2, inferior dental vein (cut); 3, inferior dental nerve; 4, inferior dental artery; 5, 6, 7, mental nerves; 8, buccal gingival margins; 9, incisive nerves; 10, mental foramen; 11, superior labial nerve; 12, facial branches of infraorbital nerve; 13, infraorbital foramen; 14, inferior palpebral; 15, lateral nasal; 16, buccal gingival margins.

Technic of Injection—Right Side.—The mucous membrane is carefully dried by using the swab shown in Fig. 369, after which the germicidal solution is applied to an area of 3 cm. in diameter (see Fig. 370). After the mucosa has been carefully prepared, care should be taken not to allow the area to become contaminated with mucus or saliva. The area prepared for the needle should extend over the ascending ramus, and as far downward and anteriorly as the lower third molar on both the buccal and lingual sides. It is also good practice to apply the germicidal solution over the crowns of the second and third molars.

The patient is placed in a semisupine position with the operator in front and at the side of the chair. The patient's mouth should be open as widely as possible, and the ascending ramus of the mandible located with the index finger. (See Figs. 371, 372 and 373.) With this finger palpate the ascending ramus, carefully locating the internal and external oblique lines, and the retromolar triangle. While palpating these bony landmarks the index finger should be located over the occlusal plane of the lower teeth on the same side. (See Figs. 373 and 390.) The anterior portion of the ascending ramus differs in width in different individuals. In some patients it is quite thin, in others it is very thick. Also in some individuals the inner oblique line is almost missing, while with others it is prominent. A triangular shaped area, which is formed by the external and internal oblique lines, is known as the retromolar triangle; with most individuals it is concave, while there are some cases in which the ascending ramus is entirely flat or convex. (See Fig. 372.) Great care should be taken not to mistake the dense connective tissue which covers the anterior surface of the masseter muscle for the ascending ramus.

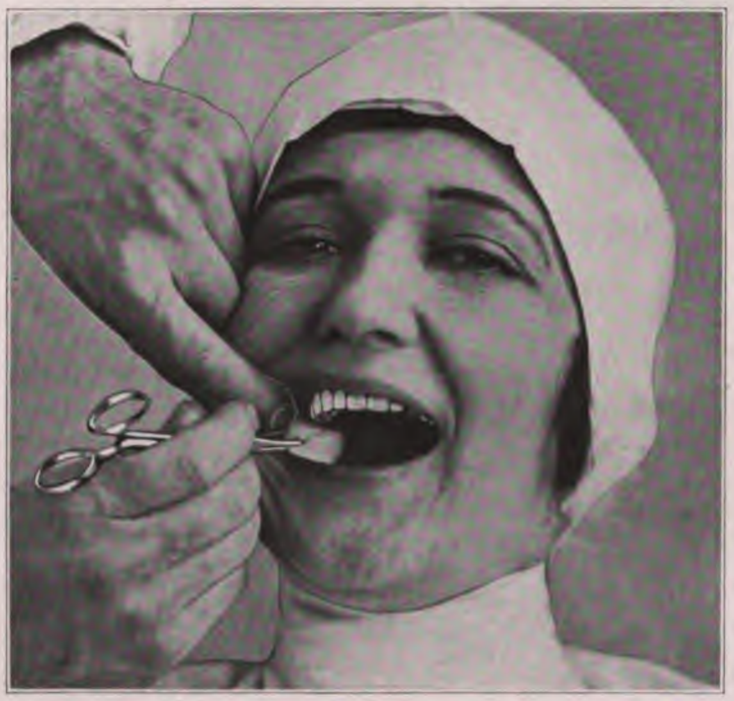

Fig. 369.—Drying mucous membrane prior to applying germicidal solution.

If there is any doubt as to the structures palpated, have the patient open and close the mouth slightly, while the tip of the index finger exerts pressure upon the part. If the connective tissue and anterior border of the masseter muscle are very prominent, or should extend anteriorly to the external oblique line, and it is these structures that are being palpated, it can be detected when the patient opens and closes the mouth, as the resistance will change. Whereas, if the index finger is in contact with the ascending ramus, the resistance will remain the same. The author has been advised by several operators that they have mistaken the anterior surface of the masseter muscle for the external oblique line, and as a result have inserted the needle exterior to the ascending ramus, with failure.

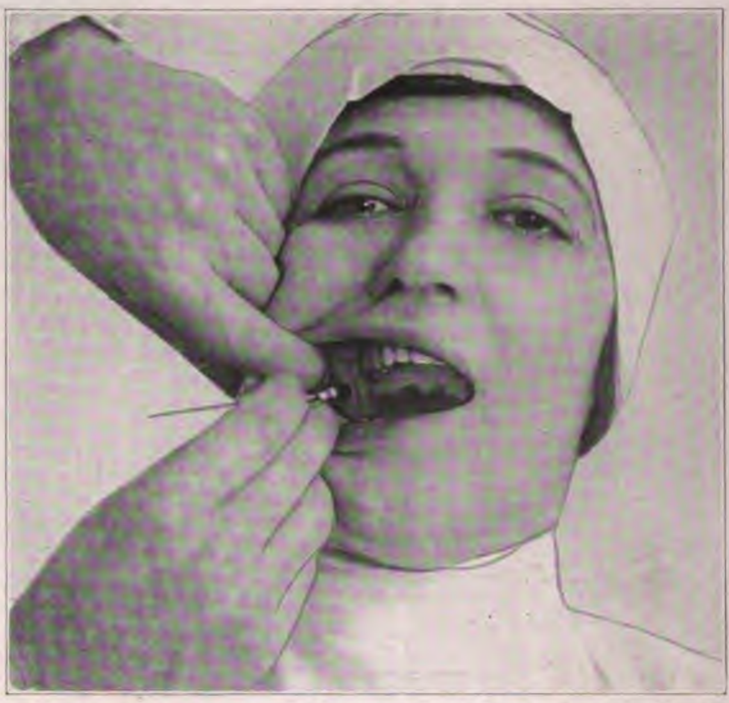

Fig. 370.—Applying the germicidal solution after the surface of mucosa is dried and prior to inserting needle.

It should be borne in mind that the retromolar triangle situated between the external and internal oblique lines, with the apex upward and base downward, is in most cases concave, and that the width of bone in this region varies in thickness with different individuals.

Some operators are too hasty in starting the needle, and as a result many times imperfect anesthesia or failure ensues. Ample time should be given to locate the bony landmarks before proceeding with the injection. After the above named landmarks have been carefully located with the palm side of the index finger resting upon the occlusal plane of the lower teeth, the dorsal surface of the index finger is turned toward the median line with the radial side resting upon the occlusal plane of the lower teeth. (See Fig. 374.) Next, extend the tip of the index finger laterally 3 or 4 mm. in order to retract the mucous membrane, thus making it tense over the internal oblique line, which also gives ample room for the needle to pass the end of the finger nail.

The average width of the index finger at the joint between the second and third phalanges is approximately 2 cm. This is easily observed by placing the index finger between two flat surfaces and measuring the distance between them. If the index finger is 2 cm. in width, then the needle is passed into the tissue at the middle and end of the finger nail (see Figs. 375, 376 and 377) while the radial side of the index finger is resting upon the occlusal plane of the lower teeth. In case the index finger is found to be less than 2 cm. in width, the initial puncture is made above the middle of the end of the finger nail, and if it is found to be wider than 2 cm. it is made below the middle of the finger nail. This serves as an excellent guide in inserting the needle into the desired location, and at the proper level for blocking the inferior dental lingual nerves. Great emphasis must be placed upon this important part of the technic because it is necessary to start the needle in the tissue at the proper level or failure will occur.

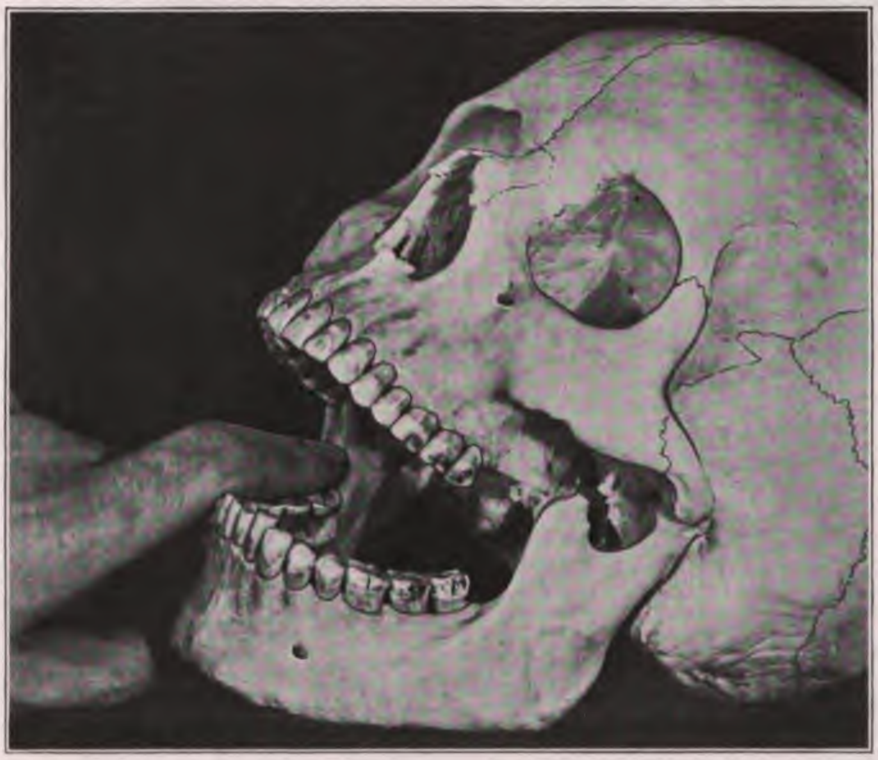

Fig. 371.—Position of index finger for locating the external and internal oblique lines and retromolar fossa of ascending ramus.

With the radial side of the index finger resting upon the occlusal plane of the lower teeth (see Figs. 375 and 376) and the finger tip resting directly over the retromolar triangle, with the finger nail directly over the internal oblique line, the cheek is drawn laterally, the tongue is depressed in order to thoroughly expose the area to receive the needle (see Fig. 377). The syringe is filled with two and a half mils of solution with the 23 gauge, 30 mm. needle, mounted upon it, and is held in the hand like a pen while writing.

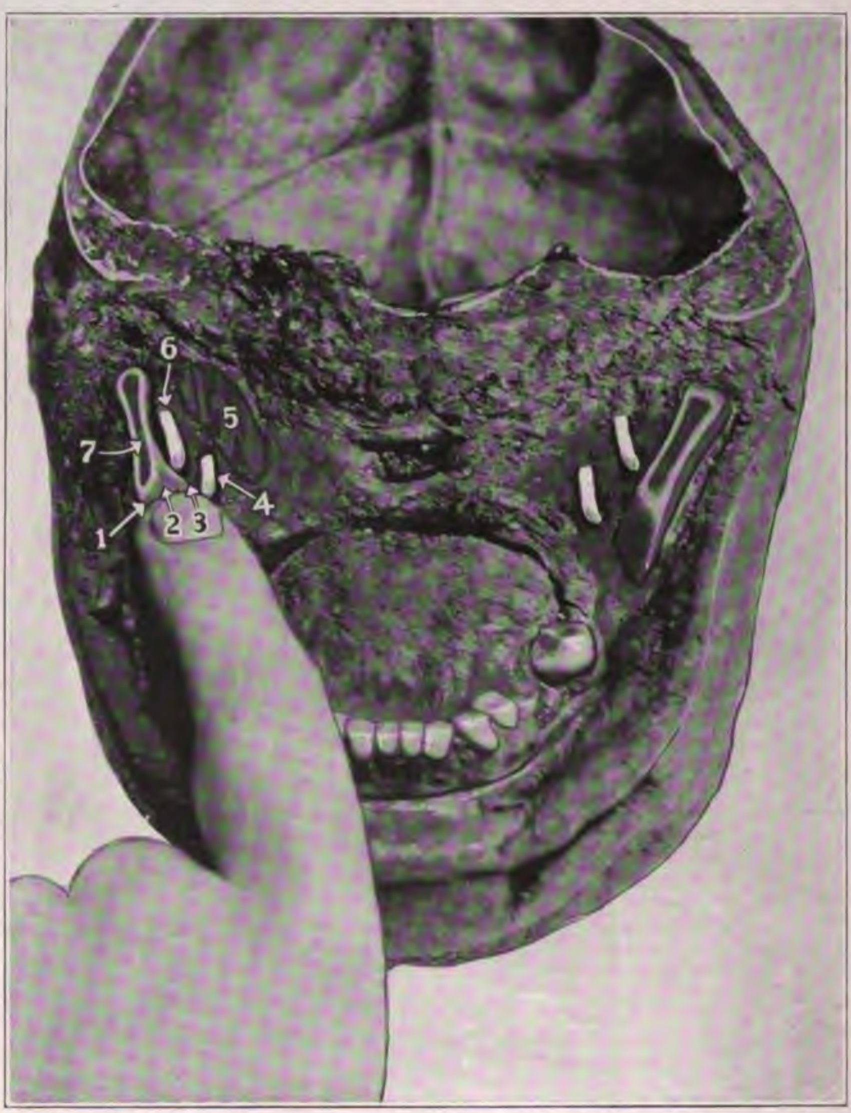

Fig. 372.—Locating the external and internal oblique lines and retromolar fossa with tip of index finger.

1, External oblique line; 2, retromolar triangle; 3, internal oblique line; 4, lingual nerve; 5, cross section internal pterygoid muscle; 6, inferior dental nerve; 7, cross section of ramus of mandible.

It is held in the right hand to make the injection on the right side of the jaw. If the injection is on the left side, hold the syringe in left hand and the various landmarks are located with the right index finger (see Figs. 391 and 392), and after the initial puncture is made the syringe is changed from the left to the right hand.

Three Positions of Syringe for Blocking the Inferior Dento-Lingual Nerves.—There are three positions advocated by the author for blocking the inferior dento-lingual nerves, and these different positions are based on anatomy. The object of this is to verify the technic step by step as the needle is advanced into the tissue, so that the location of the point of the needle is known at all times, and as a result the solution is injected in contact with the inferior dental and lingual branches, resulting in rapid profound anesthesia.

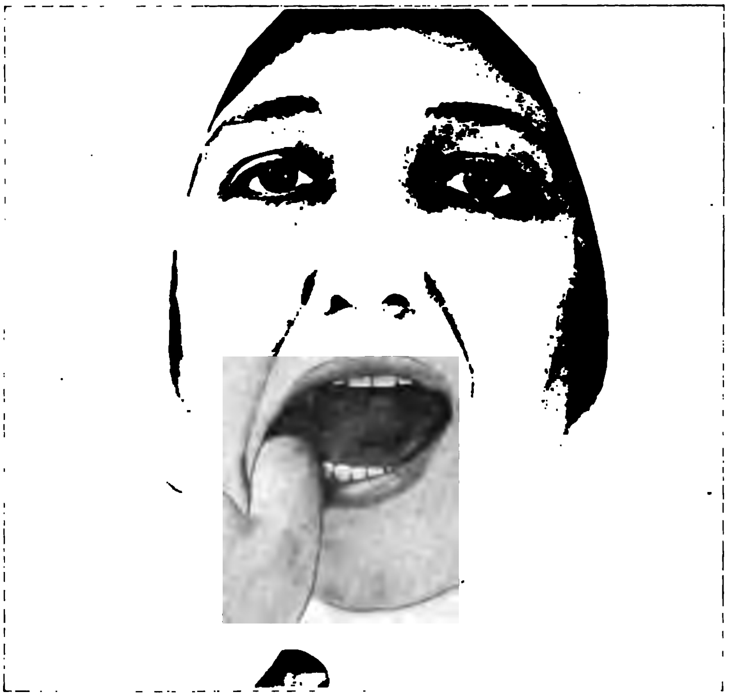

Fig. 373. Locating the external and internal oblique lines and retromolar fossa with tip of left index finger on right side. Palm of finger is resting upon the occlusal surfaces of lower teeth.

First Position of Syringe.—In Position 1 the syringe is held in the hand pen fashion, and the barrel is resting on the occlusal surface between the cuspid and first bicuspid teeth on the opposite side of lower jaw. (See Figs. 375, 376, 377, and 378.) The radial side of the index finger should rest on the occlusal surface of the lower teeth at this time. The needle is forced through the mucosa backward and slightly laterally at the middle of the finger nail until the internal oblique line is reached; the average depth of the needle is 5 mm. (see Fig. 379). When the point of the needle has reached the periosteum covering the internal oblique line (see Fig. 378), withdraw the index finger from its original position and distend the cheek, which will expose the area of insertion, and the operator will have a clear view of the parts (see Fig. 377). The object of striking the inner oblique line is to prove that the needle is proceeding in the proper direction, and that it is not located in the soft tissues medially to the internal oblique line.

Second Position of Syringe.—The syringe is extended across the median line to the opposite side of the arch on the same side of injection. (See Figs. 380, 381, 382, and 383.) Caution must be exercised not to force the needle beneath the periosteum covering the internal oblique line, because if this is done the periosteum will bind the needle to the inner oblique line and prevent the carrying out of the desired technic in Position 3. Fig. 399 shows the needle which has been forced below the periosteum and what has happened. In Position 1 it was stated that the approximate depth of the needle from the starting point to the periosteum covering the internal oblique line was 5 mm. (See Fig. 376.) With the syringe in Position 2 the needle is

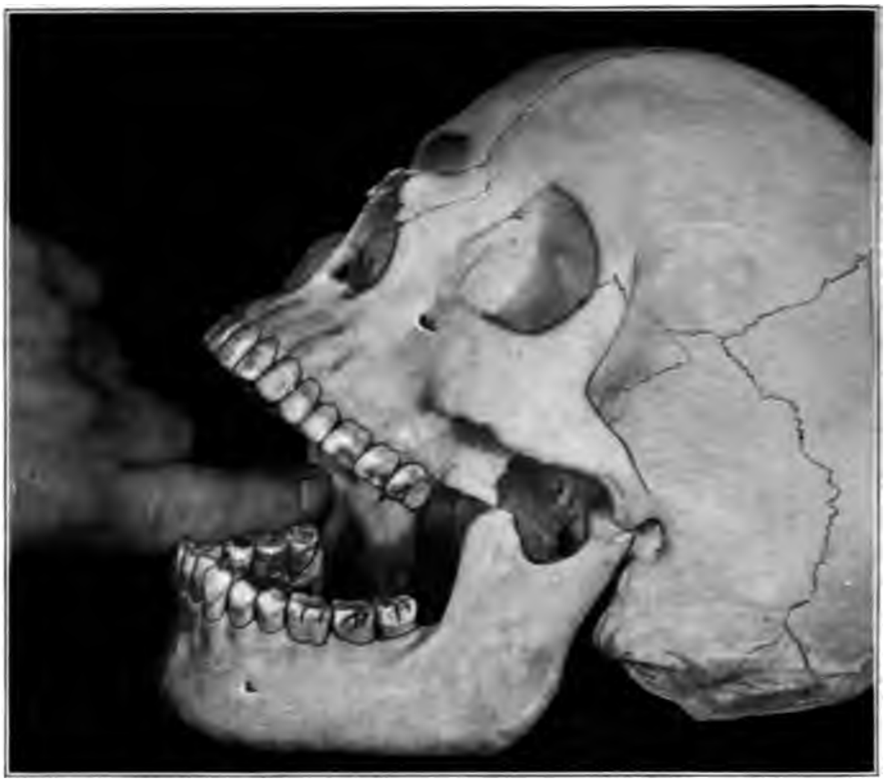

Fig. 374.—Radial side of index finger resting upon occlusal surfaces of lower teeth. Tip of finger resting over retromolar fossa; end of finger nail over internal oblique line with dorsal surface turned towards median line.

forced backward and medially another 5 mm., which makes a total depth of 1 cm. At this time the point of the needle should be in the immediate region of the lingual nerve (see Figs. 382 and 383). The object of carrying the syringe outside the arch on the same side of injection from Position 1, is to direct the needle toward the lingual nerve. The lingual nerve is located approximately 10 mm. from the needle puncture in the mucous membrane, also approximately 5 to 7 mm. mesial and posterior to the internal oblique line, and approximately 1 cm. anterior and medial to the inferior dental nerve. (See Fig. 379.)

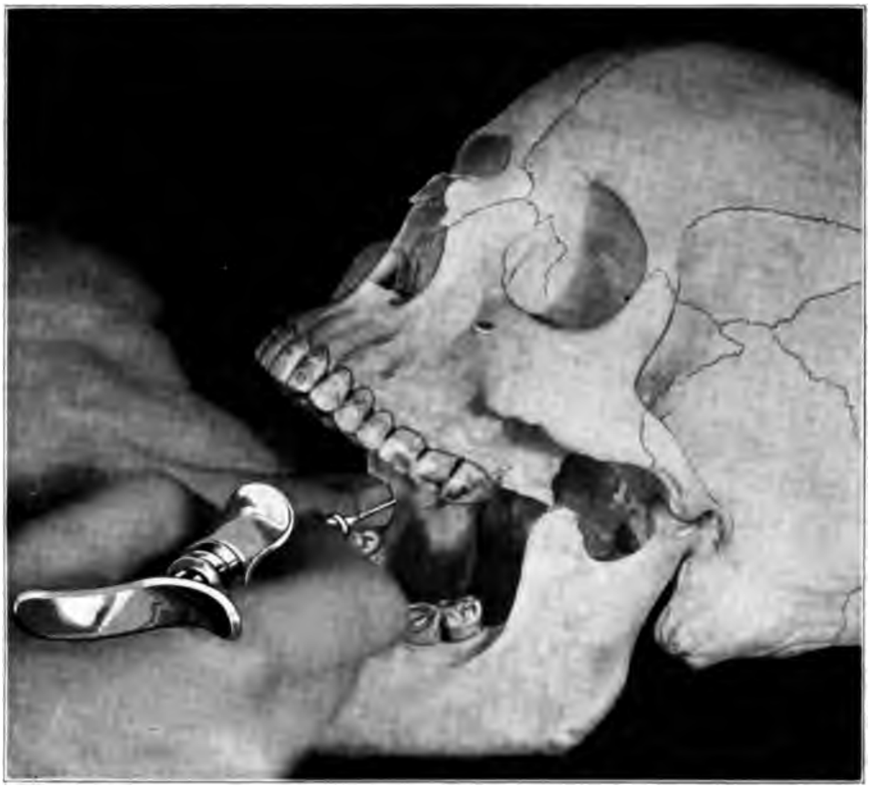

Fig. 375.—Illustrating the first position of syringe for blocking the inferior dental-lingual nerves on right side. The point of needle is in contact with the periosteum covering internal oblique line.

While the syringe is in Position 2, one-half mil of solution is slowly injected into the region of the lingual nerve. If the needle is extended backward from the lingual nerve without changing its direction to Position 3, as given below, the needle will enter the sphenomaxillary ligament, or the internal pterygoid muscle, or both of these structures, as is illustrated in Fig. 397. To avoid this very common occurrence, the direction of the needle is changed to the third position as shown in Figs. 386 and 387.

Third Position of Syringe.—The syringe is now changed from Position 2, (shown in Figs. 382 and 383) to Position 3 (shown in Figs. 384, 385, 386 and

387). This is accomplished by extending the syringe to the opposite side, and the distance which it is advanced across the median line depends on the divergence of the two ascending rami. The two rami differ in various individuals as to the amount of divergence from their anterior-posterior aspect. After injecting the lingual nerve, the needle is then advanced approximately one centimeter backward and laterally to region of the inferior dental nerve. (See Figs. 386 and 387.) It is advisable that the point of the needle be in contact with the periosteum in the region of the inferior dental foramen at the time the solution is being injected to block the inferior dental nerve.

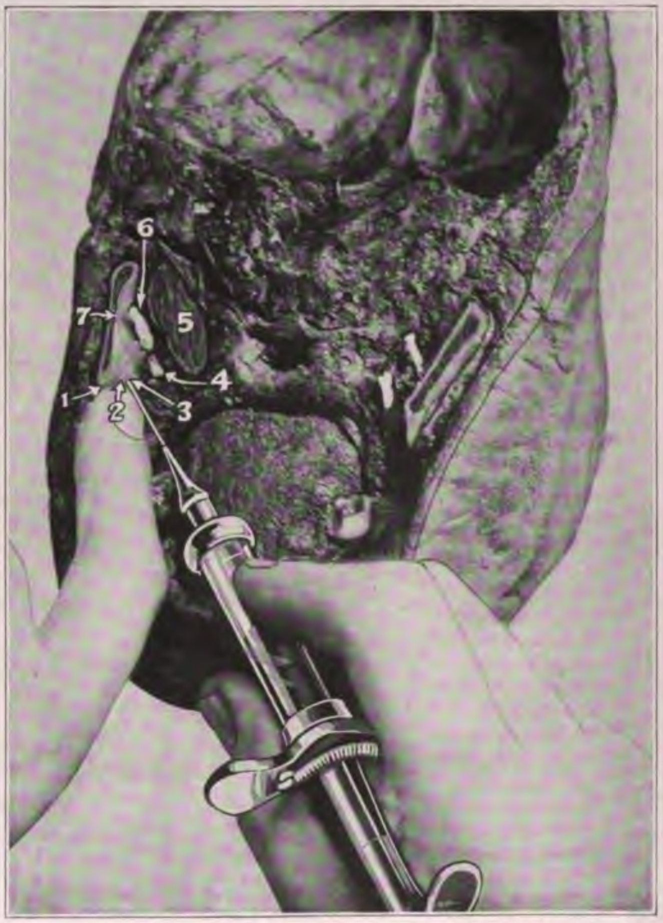

Fig. 376.—Wet specimen illustrating first position of syringe for blocking the inferior dental-lingual nerves on right side. The point of needle is in contact with the periosteum covering the internal oblique line.

1, External oblique line; 2, retromolar triangle; 3, internal oblique line; 4, lingual nerve; 5, cross section of internal pterygoid muscle; 6, inferior dental nerve; 7, cross section of ramus of mandible.

It can be said that in most cases the barrel of the syringe is in contact with the surfaces of the lower teeth between the median line and cuspid while the solution is being injected. (See Figs. 384 and 386.) In some cases, however, the barrel of the syringe assumes the same position, as described above, under first position of syringe. The writer wishes to emphasize this particular phase of the technic, so the operator will avoid infiltrating the sphenomaxillary ligament and internal pterygoid muscle. If the barrel of the syringe is not located far enough laterally on the opposite side of injection to direct the needle backward and laterally as is illustrated in Fig. 386, the needle point will not be in contact with the periosteum of the ascending ramus in the immediate region of the inferior dental canal and nerve. This one mistake has been the cause of hundreds of patients suffering postoperative pain from the solution which was not injected properly, and the writer is positive that if the technic is followed, as here given, little, if any, postoperative pain will be experienced from this cause. The operator may feel sure that the needle is not located in the sphenomandibular ligament or the internal pterygoid muscle when he detects that the needle point is in contact with the periosteum, as is illustrated in Fig. 386. With the needle in this position the point is located from seven to ten millimeters to the lateral of the sphenomandibular ligament and internal pterygoid muscle, and when the solution is injected, very little will permeate these structures. The lateral surface of the sphenomandibular ligament, the internal pterygoid muscle, and the inner surface of

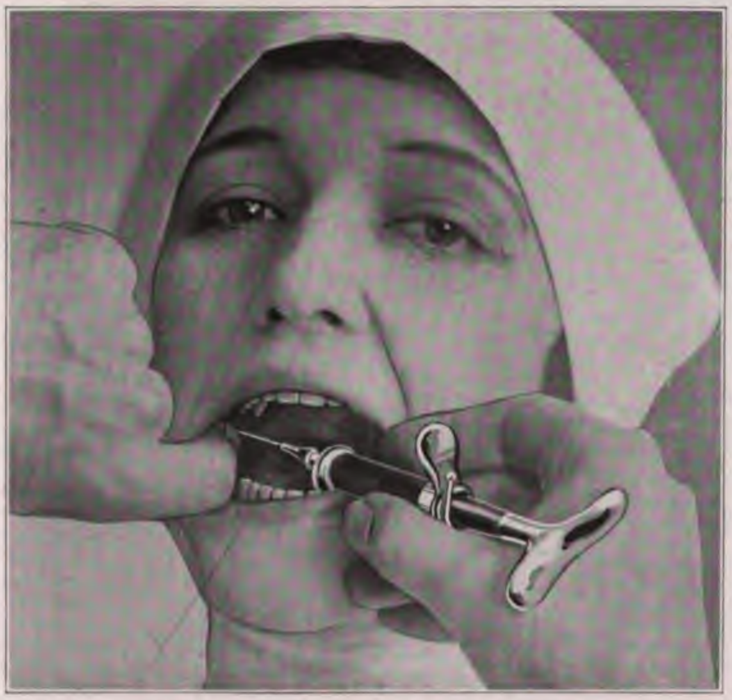

Fig. 377.—Illustrating first position of syringe for blocking the inferior dental-lingual nerves. Approximate depth of needle is 5 millimeters. Point of needle in contact with the periosteum covering internal oblique line. (See Fig. 376.)

the ascending ramus form two triangles. One of these triangles has its base located anteriorly, with its apex posteriorly, while the other has its base superiorly with its apex inferiorly. Therefore, the deeper the needle is inserted into the first triangle above mentioned, with its base located anteriorly, the nearer it approaches the sphenomandibular ligament and internal pterygoid muscle. The average distance between the internal oblique line and the lateral surface of the anterior margin of the internal pterygoid muscle is 15 mm.; the average distance between the inferior dental foramen and the lateral portion of the sphenomaxillary ligament is 8 mm.; the average distance between the inner surface of the ramus and internal pterygoid muscle in the region ½ cm. posterior to the inferior dental nerve is from 5 to 6 mm.

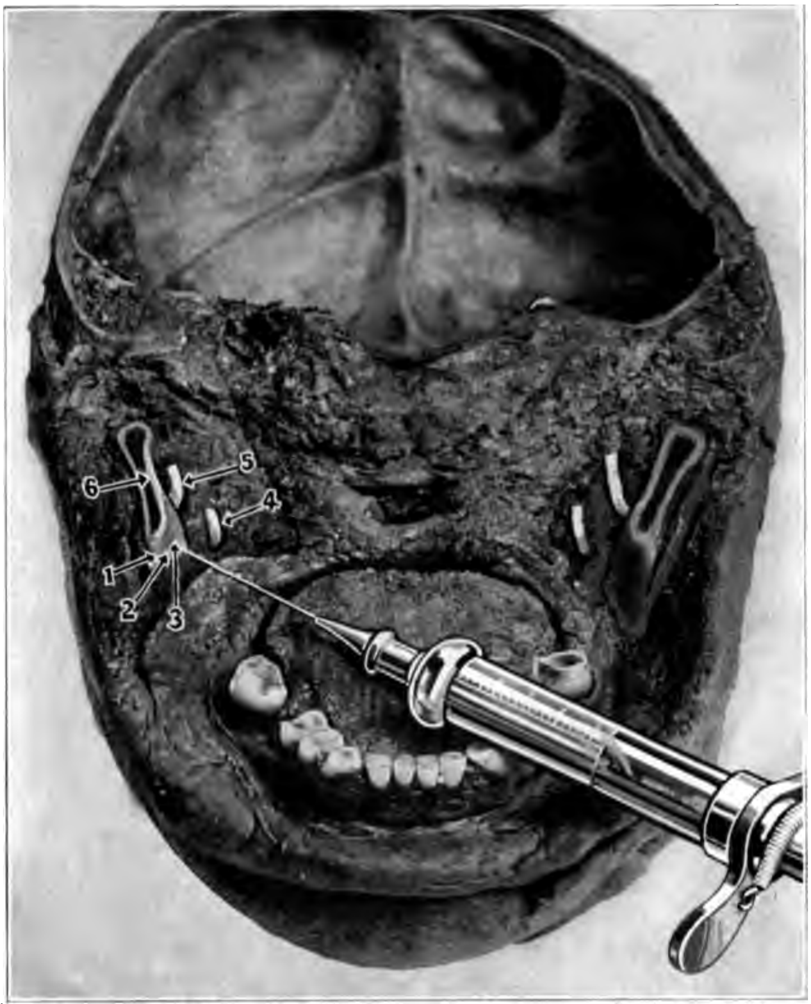

Fig. 378.—First position of syringe for blocking the inferior dental-lingual nerves. Point of needle in contact with periosteum covering internal oblique line at approximate depth of 5 millimeters.

1, External oblique line; 2, retromolar triangle; 3, internal oblique line; 4, lingual nerve; 5, inferior dental nerve; 6, cross section ramus of mandible.

After the syringe is changed from Position 2 to Position 3, the needle is advanced into the tissue posteriorly and laterally 1 cm. which makes an approximate total depth of 2 cm. and the syringe is worked back and forth through a distance of 2 mm. and at the same time carrying it laterally until the point of the needle is detected in contact with the periosteum covering the inner

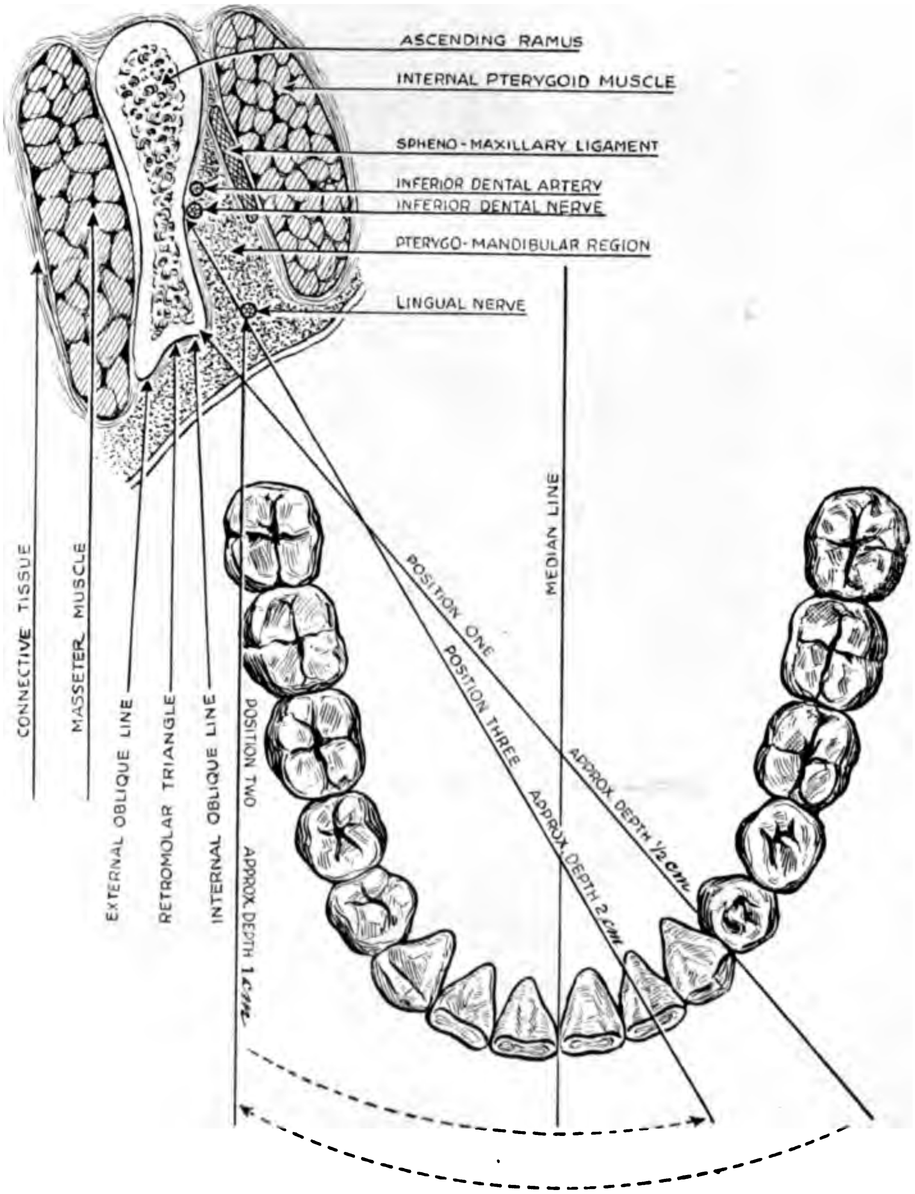

Fig. 379.—Diagrammatic cross section one centimeter above the occlusal plane of lower teeth showing the first, second and third positions of syringe and needle for blocking the inferior dental-lingual nerves.

surface of the ramus. After this has been accomplished, the operator is positive that the solution will be injected in close contact with the inferior dental nerve. Fig. 386 shows the point of the needle located between the inferior dental nerve and periosteum which is the correct location to inject the solution.

The Depth of Needle.—It can be said that the average distance which the needle is inserted is 1 cm. to block the lingual nerve and 2 cm. to block the inferior dental. However, in some cases, as with a large individual, the total depth for the inferior dental may be from 23 to 25 mm., while with a child or an individual with a small jaw, the total depth may vary from 12 to 16 mm. After making thousands of injections the author is of the opinion that the average depth for the lingual nerve is 1 cm., and the inferior dental nerve 2 cm. It is very helpful to the operator to know the approximate distance to insert the needle, and when he uses needles of known length he always has a check upon his technic, and encounters very few failures.

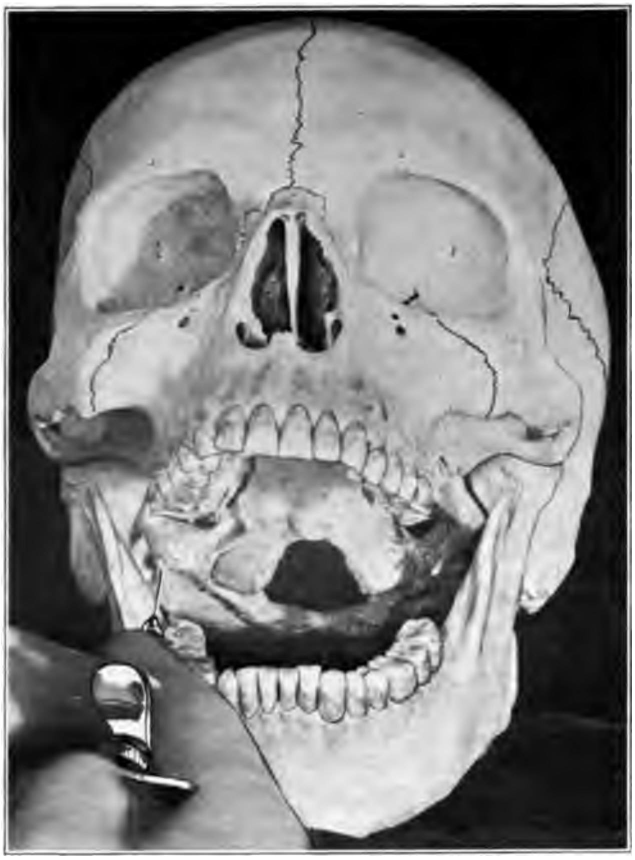

Fig. 380.—Second position of syringe for blocking inferior dental nerve.

RECAPITULATION OF THE VARIOUS DEPTHS OF NEEDLE WHILE BLOCKING THE INFERIOR DENTO-LINGUAL NERVES

1. Approximate depth from puncture point to internal oblique line is 5 mm. (See Position 1 in Figs. 378 and 379.)

2. From internal oblique line to lingual nerve is approximately 5 mm., which makes a total of 1 cm. from puncture of mucosa. (See Position 2 in Figs. 379 and 382.)

3. From lingual nerve to inferior dental nerve is approximately one centimeter. (See Fig. 378.)

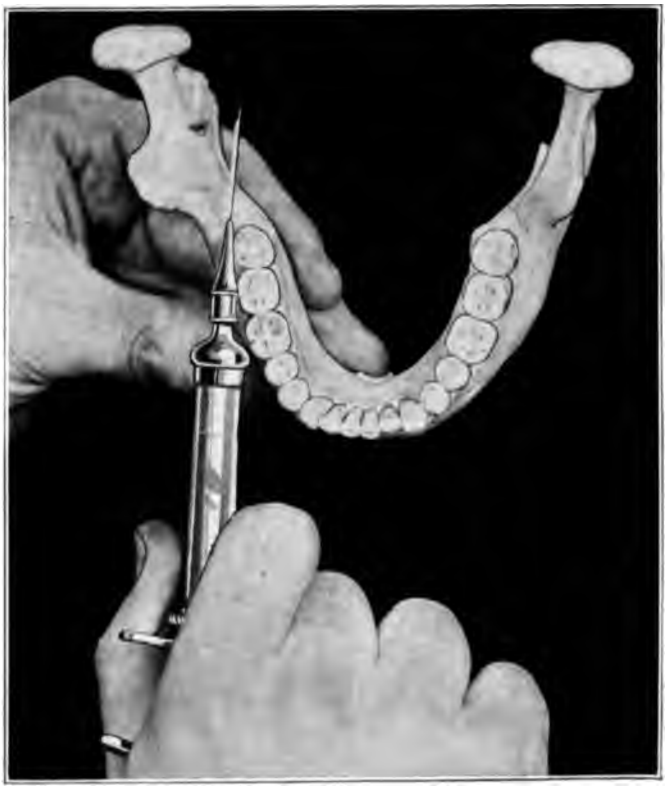

Fig. 381.—Second position of syringe for blocking inferior dental nerve.

4. Total approximate depth of needle in tissue while blocking the inferior dental nerve is 2 cm. (See Fig. 387.)

5. The needle employed is 30 mm. in length, therefore 1 cm. will remain exterior to the surface. (See Figs. 379 and 386.)

Injection of Solution.—As a rule, no solution is injected during the first position of the syringe, that is, while the needle is being advanced into the mucous membrane towards the internal oblique line, unless the patient is hypersensitive. As has been stated several times in the text, it is always permissible

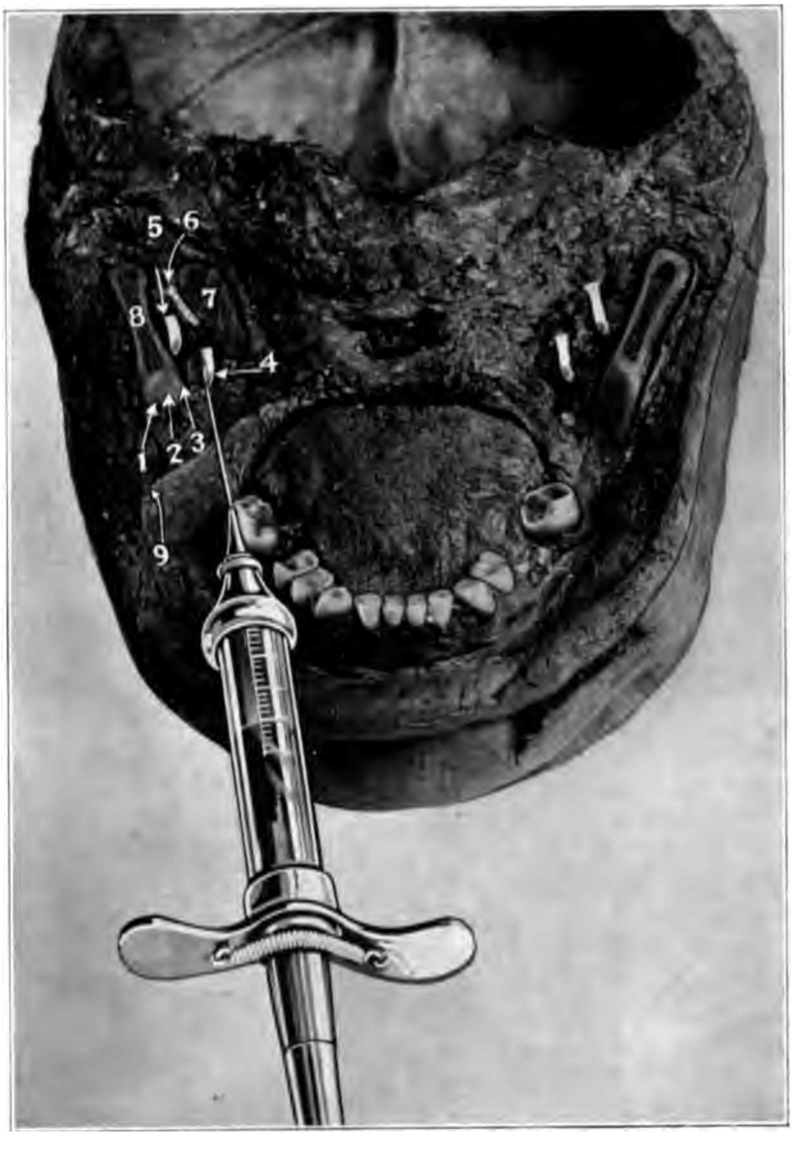

Fig. 382.--Second position of syringe for blocking the lingual nerve. Needle point in contact with lingual nerve. Approximate depth of needle is 1 centimeter.

1, External oblique line; 2, retromolar triangle; 3, internal oblique line; 4, lingual nerve; 5, inferior dental nerve; 6, cross section sphenomaxillary ligament; 7, cross section internal pterygoid muscle; 8, cross section of ascending ramus.

to inject the solution regardless of the point of the needle if the patient experiences pain. However, it is seldom that any appreciable pain is experienced by the patient while advancing the needle into the tissues in the region of the lingual and inferior dental nerves. The syringe is filled with 2½ mils of solution, ½ mil is injected for the lingual nerve, and 1½ to 2 mils for the inferior dental nerve. The solution should never be injected faster than one minim per second thus giving the delicate connective tissue in the region of the nerve branches ample time to accommodate itself to the presence of the solution and to prevent the so-called "ballooning" of the tissue, which would result in injury, causing postoperative pain.

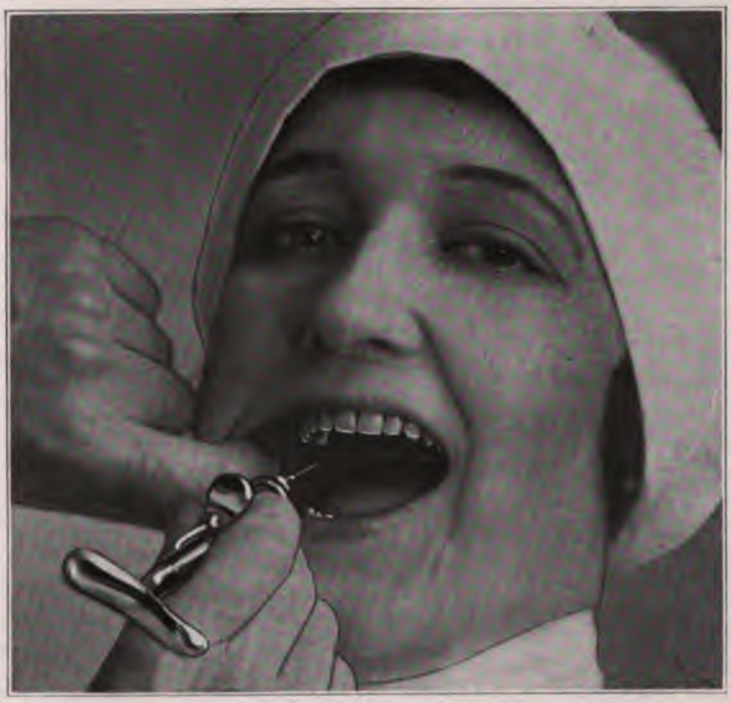

Fig. 383.—Second position of syringe for blocking lingual nerve. Approximate depth of needle is 1 centimeter. (See Fig. 382.)

Technic of Injection—Left Side.—The technic is similar to that already described for blocking the right inferior dento-lingual nerves, with the exception of the following points of difference: Locate the external and internal oblique lines, retromolar triangle with the right index finger; hold the syringe in the left hand during Position 1 only. Then, if desired, take the syringe in the right hand and place the right arm around the patient's head, distending the cheek, etc. (See Fig. 396.) The syringe is held in the left hand at the start because the field is easily seen when the right hand is distending the cheek. In most cases the author adjusts the syringe to the three positions without changing to the right hand. (See Figs. 390, 391, 392, 393, 394, 395, and 396.)

Precautions.—The operator should carefully follow the technic in manipulating the syringe in the three positions, and should make it a rule never to inject the solution for the inferior dental nerve unless the point of the needle is in contact with the periosteum in the region of the inferior dental foramen. This assures him that the needle is in the correct location and not near the sphenomaxillary ligament or internal pterygoid muscle. Caution should be exercised not to advance the needle to a greater depth than 1 cm. for injecting the lingual nerve, as if this is done, Fig. 397 shows what would happen. The needle would enter the internal pterygoid muscle or ligament, and the injection of solution at this point may cause postoperative pain. The depth of the needle varies slightly in different individuals, and if the operator is famil- r with the position of the nerves in the average case, it should not be difficult him to apply the technic to various cases. Many operators have failed to

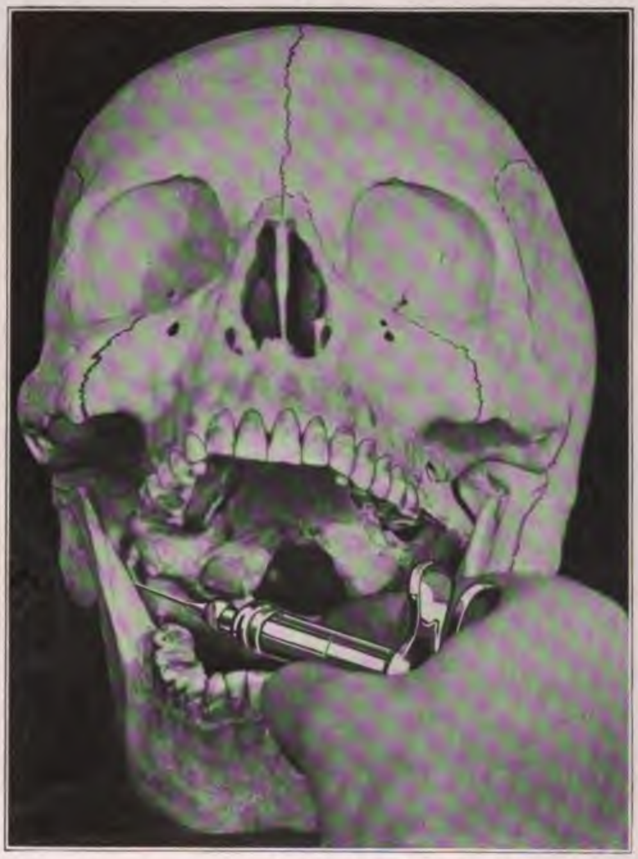

Fig. 384.—Third position of syringe for blocking the inferior dental nerve. (See Fig. 386.)

produce anesthesia of the inferior dental nerve because the needle was inserted too far posteriorly and the solution injected posterior to the dental nerve as illustrated in Fig. 398. The bevel of the needle, which is indicated by the blank side of the hub, should be toward the periosteum, thus preventing the point from becoming engaged beneath the periosteum.

Care should be taken not to force the needle beneath the periosteum when it strikes the anterior aspect of the inner oblique line. After some experience the operator will develop a touch which is very valuable to him in detecting the instant the needle point strikes the internal oblique line in Position 1 and the region of the inferior dental foramen in Position 3. While advancing the needle, should any resistance be detected, which is in most cases due to its being forced beneath the periosteum, the needle should never be advanced farther, as such a procedure will force the periosteum from the bone, and may result in postoperative complications. There is also danger of breaking the needle. (See Fig. 399.) If any resistance is experienced, the needle should be withdrawn, its direction slightly changed, and then advanced in accordance with the technic given.

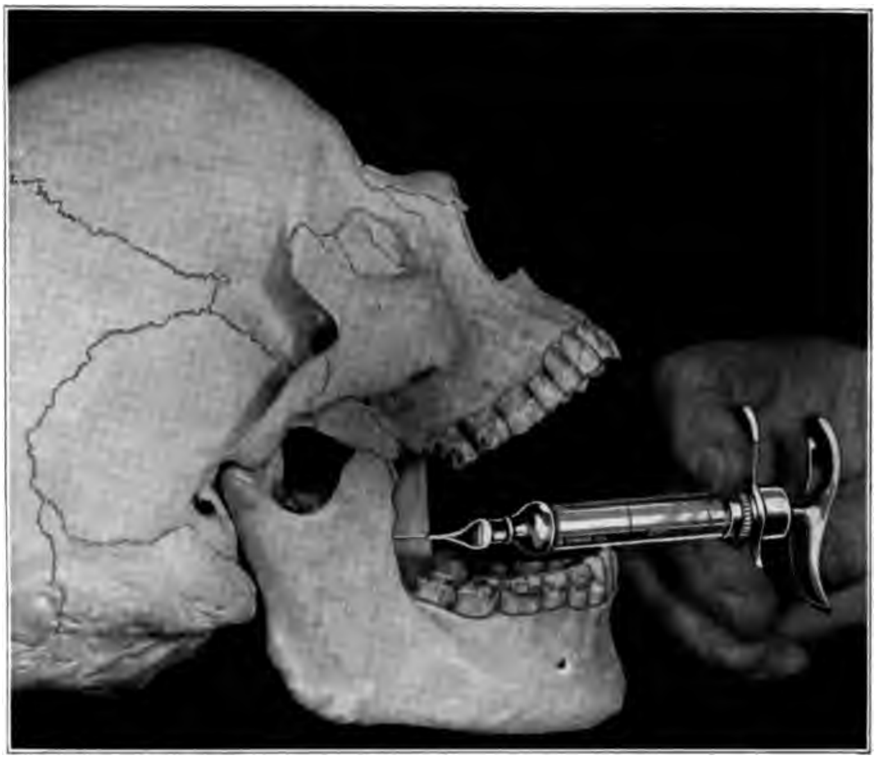

Fig. 385.—Lateral view of needle for blocking the inferior dental nerve while syringe is in position three at a level of 1 centimeter above occlusal plane of lower teeth.

While the solution is being injected in the region of the inferior dental nerve, the needle should be moved back and forth at least 2 mm., so as to facilitate the discharging of the solution. In some cases the bevel is in close contact with the periosteum, and considerable pressure is required to discharge the solution from the syringe, if the needle is held perfectly still; therefore, slight movement of the needle in an anterior-posterior direction greatly aids in emptying the syringe. The needle should never be inserted to the hub, but instead, at least 1 cm. should be left external to the tissue, and if the needle should break at the hub, it can be easily removed.

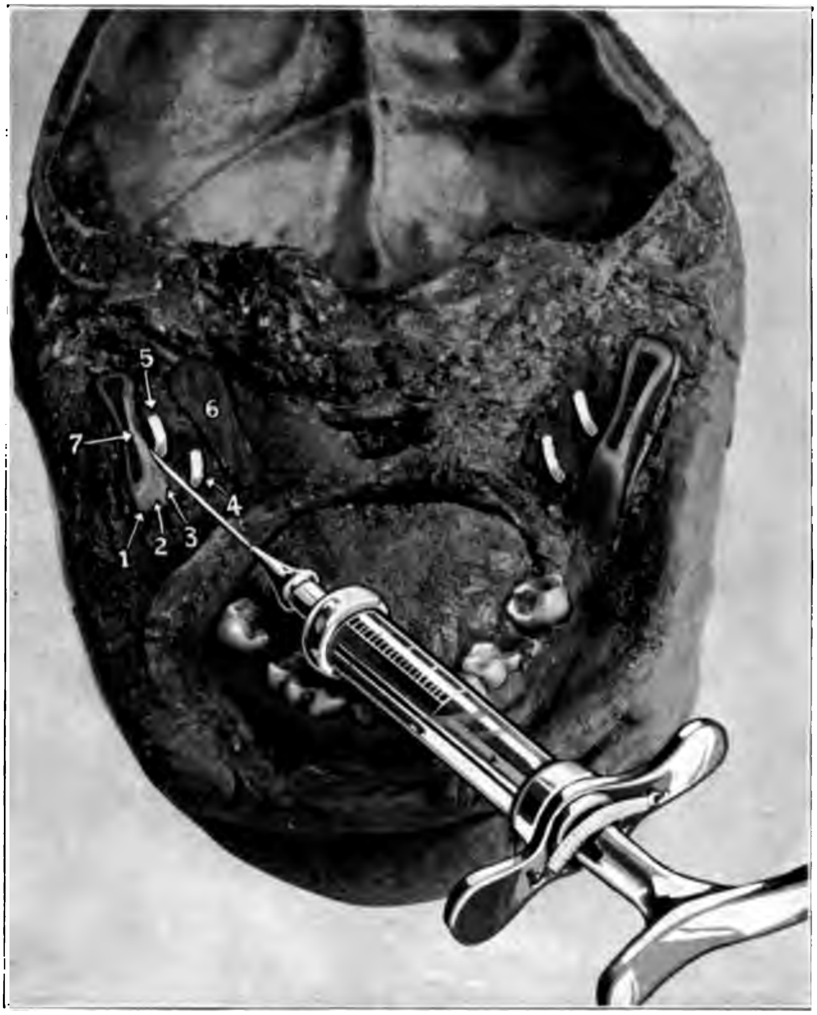

Fig 386.—Wet specimen illustrating third position of syringe for blocking the inferior dental nerve. Needle point in contact with periosteum and inferior dental nerve. Approximate depth of needle is 2 centimeters.

1, External oblique line; 2, retromolar triangle; 3, internal oblique line; 4, lingual nerve; 5, inferior dental nerve; 6, cross section of internal pterygoid muscle; 7, cross section of ascending ramus.

The Plane or Level to Insert the Needle.—In the middle-aged patient the needle is extended backward at a point 1 cm. above and parallel to the occlusal plane of the lower teeth. (See Figs. 400 and 403.) With the child or a patient advanced in years, the barrel of the syringe is elevated slightly, and the needle is directed downward. (See Figs. 401, 402, and 404.)

The Lingula.—The lingula is a spicule of bone which is located anteriorly and superiorly to the opening of the inferior dental canal. (See Fig. 407.) This bony prominence is situated anteriorly to the inferior dental nerve, vein and artery. In some individuals the lingual is quite large and may interfere with the advancement of the needle in the region of the periosteum covering the ascending ramus just before the inferior dental nerve enters the canal. at which point the solution is injected. While the needle is being advanced, as illustrated in Position 3 (see Fig. 386), if this bony prominence is large, the needle may come in contact with its anterior portion. If this is encountered the needle should be slightly elevated so as to extend its point above the lingula.

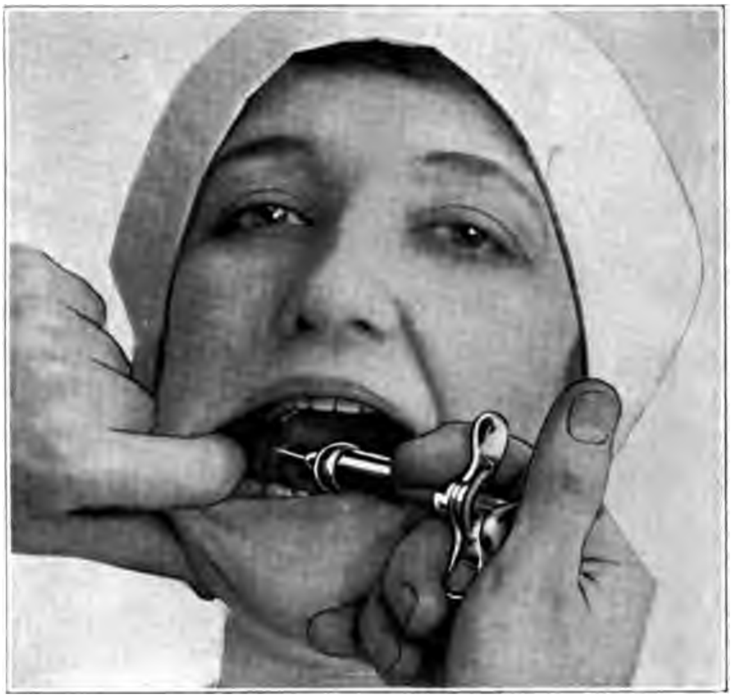

Fig. 387.—Third position of syringe for blocking inferior dental nerve. Point of needle is in contact with periosteum and near inferior dental nerve. Approximate depth of needle is 2 centimeters. (See Fig. 386.)

The Inferior Dental Artery and Vein.—The inferior dental artery and vein are in most cases located to the distal of the inferior dental nerve, are protected anteriorly by the lingula and nerve, and are surrounded by connective tissue and pass into the inferior dental canal. (See Figs. 405 and

406.) *If a straight needle which has a short, sharp bevel is employed, it is exceedingly difficult to puncture an artery as an artery is elastic and is surrounded by loose, connective tissue, and has a tendency to pass to one side or the other.* After extended experience the author has not, to his knowledge, ever punctured the inferior dental artery or vein, and is sure that no difficulty will be encountered, provided the bevel of the needle is in contact with the periosteum lateral to the opening of the inferior dental canal, as is shown in Position 3 as illustrated in Figs. 379 and 386.

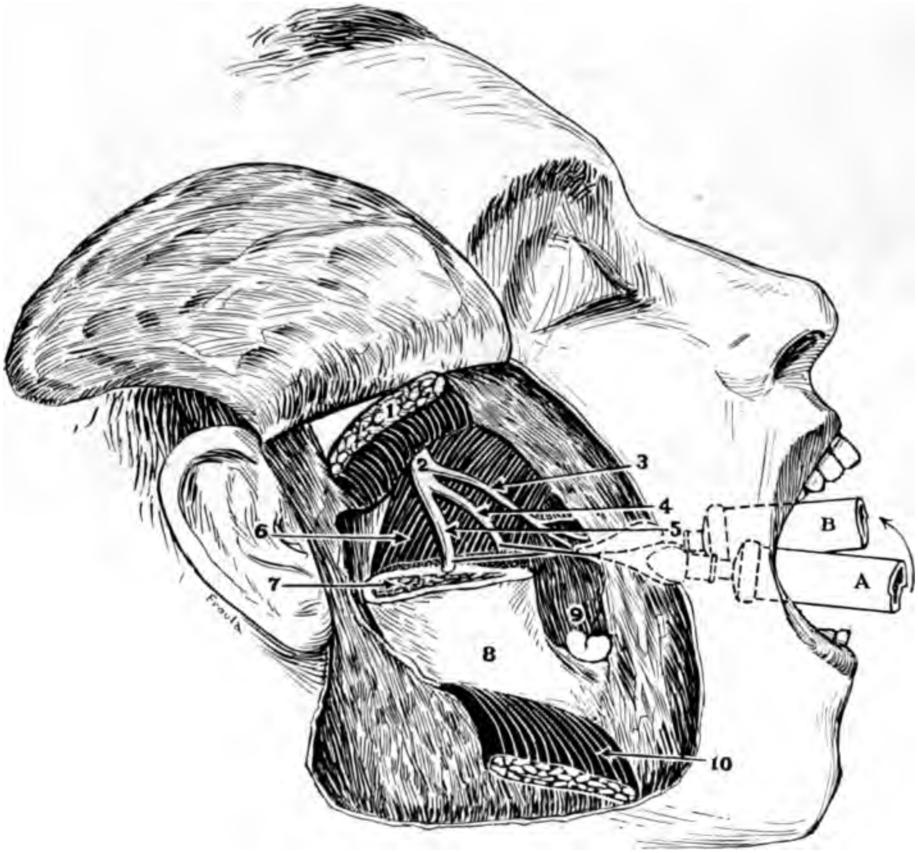

Fig. 388.—Anatomical drawing illustrating the second and third positions of syringe for blocking the inferior dental-lingual nerves.

A. Second position—needle point in contact with lingual nerve.

B. Third position—needle point in contact with periosteum and inferior dental nerve.

1, Cut portion masseter muscle—turned up; 2, mandibular nerve; 3, long buccal nerve; 4, lingual nerve; 5, inferior dental nerve; 6, internal pterygoid muscle; 7, cross section ascending ramus; 8, external surface ascending ramus; 9, lower third molar; 10, masseter muscle—cut.

The Pterygomandibular Region.—The pterygomandibular region is bounded mesially by the lateral surfaces of the sphenomaxillary ligament and internal pterygoid muscle, and laterally by the medial surface of the ascending ramus. (See Fig. 379.) In a way two triangles are formed, one of which

has its base upward and apex downward, while the other has its base anteriorly with its apex posteriorly. Therefore, the lateral surface of the spheno-maxillary ligament and the internal pterygoid muscle is located nearer the ascending ramus posteriorly than it is anteriorly; when the needle is inserted into the region of the inferior dental nerve, the operator must not lose sight of this fact. A cross section at a point 1 cm. above the occlusal plane of the lower teeth is illustrated in Fig. 379. The solution is injected at this level. The contents of the pterygomandibular region are the inferior dental nerve,

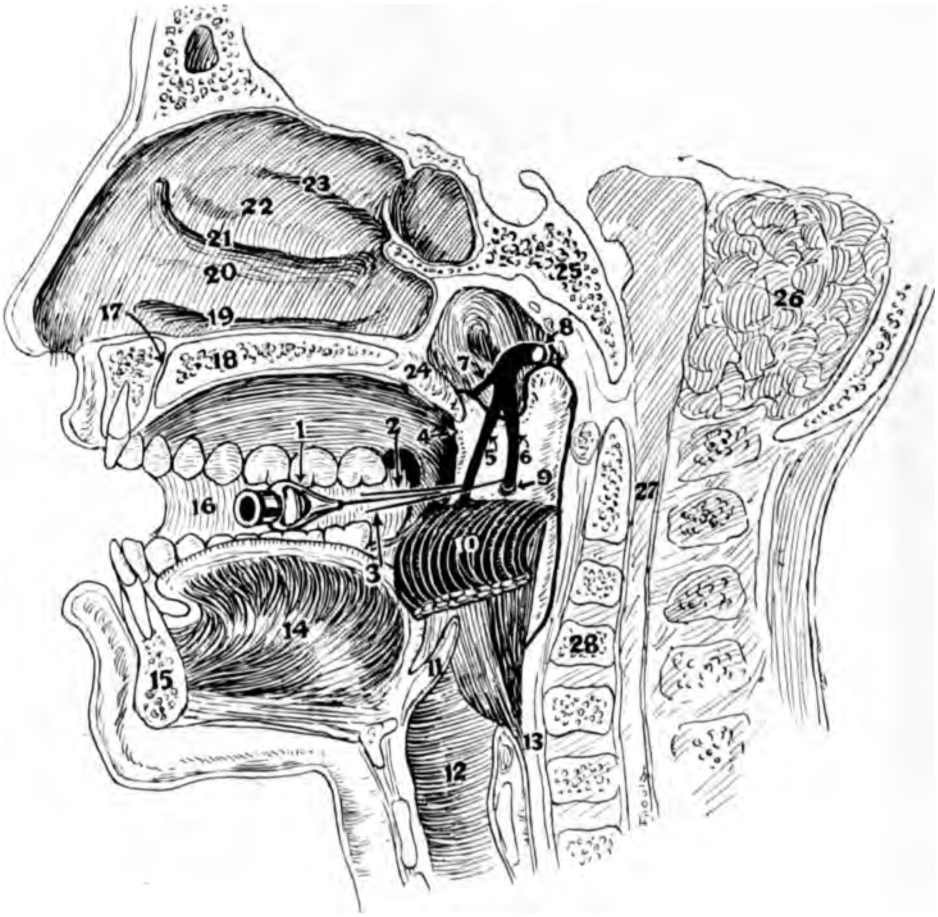

Fig. 389.—Anatomical drawing illustrating the first, second and third positions of needle for blocking the inferior dental-lingual nerves.

1. First position of needle—needle point is in contact with periosteum covering internal oblique line; 2, second position of needle—needle point near lingual nerve; 3, third position of needle—needle point situated near inferior dental nerve; 4, ascending ramus; 5, lingual nerve; 6, inferior dental nerve; 7, long buccal nerve; 8, third or mandibular division; 9, inferior dental foramen; 10, internal pterygoid muscle (cut); 11, epiglottis; 12, trachea; 13, esophagus; 14, median section of tongue; 15, section of mandible in median line; 16, cheek; 17, anterior palatine canal; 18, section of palate bone at median line; 19, inferior turbinate bone; 20, middle meatus; 21, middle turbinate bone; 22, superior meatus; 23, superior turbinate bone; 24, soft palate in median line; 25, sphenoid bone; 26, cerebellum; 27, spinal cord; 28, cervical vertebra.

artery and vein, lingual nerve, artery and vein, adipose and loose connective tissues. These loose connective and adipose tissues readily absorb the solution when injected for the lingual and inferior dental block. It is in the pterygomandibular region that the solution is injected, and not beneath the periosteum or into the sphenomaxillary ligament or internal pterygoid muscle. (See Fig. 407.)

Location of the Internal Oblique Line of the Ascending Ramus.—The location of the internal oblique line is rather misleading to many operators and the misjudging of its location has been the result of many failures in the blocking of the inferior dentolingual nerves. During the author's experience he has in a number of cases observed the operator starting the needle at a point too near the median line, instead of that illustrated in Figs. 375 and 376, while the syringe is in the first position. The exact location of the internal oblique line must be determined by careful palpation, and it is highly important that it be located before making the initial puncture. The prominence of this bony landmark varies a great deal with different individuals, in some of whom it is almost missing, while in others it is well developed even to the extent that it may give the operator some difficulty in advancing the needle. In case it is extremely prominent, the needle must be carried more medially.

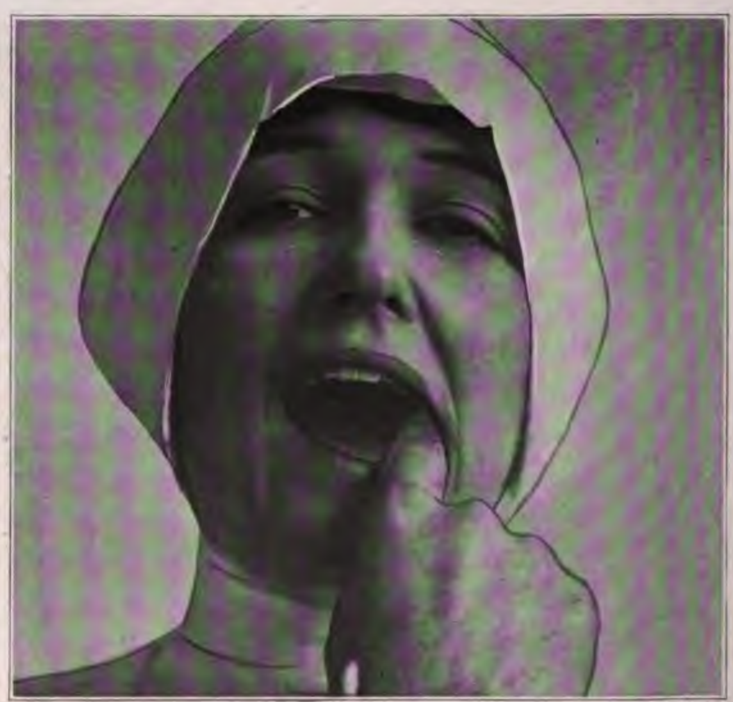

Fig. 390.—Locating the external and internal oblique lines and retromolar fossa with tip of right index finger on left side.

Without reviewing their osteology, most operators are under the impression that the anterior portion of the internal oblique line is located directly posterior to the lower third molar, but if the osteology is studied, it will be found that the internal oblique line is located laterally to an anteroposterior line drawn along the buccal surfaces of the lower teeth. (See Fig. 379.) In many instances the author has been told by those observing the technic, that they were surprised to see how far laterally the needle was inserted into the tissue, or that they were under the impression that the point of the needle was inserted into the mucosa directly posterior to the lower third molar. This common mistake can not be emphasized too strongly, as many operators have inserted the needle too far lingually to the internal oblique line, which has resulted in infiltrating the internal pterygoid muscle, sphenomaxillary ligament, thus causing postoperative pain. If the solution is injected in accordance with Positions 2 and 3 the muscle and ligament will not be infiltrated, and no discomfort will follow the injection.

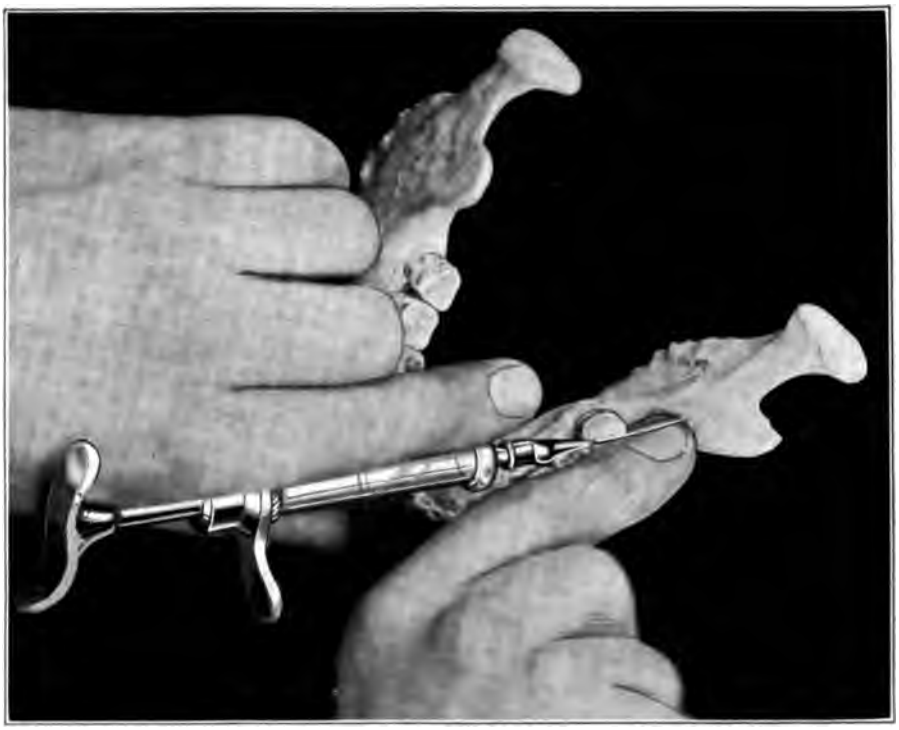

Fig. 391.—Illustrating first position of syringe for blocking inferior dental-lingual nerves on left side. The point of needle is in contact with the periosteum covering internal oblique line.

Postoperative Pain Caused by Improperly Injected Solution.—It is well to remember that the delicate tissues which fill the pterygomandibular region are very sensitive and respond to the slightest trauma; also, that infiltration of the pterygoid muscle or sphenomaxillary ligament, will cause postoperative discomfort or pain, from the fact that the internal pterygoid muscle is constantly undergoing contraction and relaxation during the movement of the mandible while talking or masticating. A patient will notice any slight deviation from the normal more readily in this region than in any other by the block method. The reason for this is that the tissues are susceptible to trauma. Great importance must also be attached to the fact that the solution should be injected while the point of the needle is located near the periosteum in the region of the inferior dental foramen; the solution should be slowly injected and be near body temperature. If the operator questions the necessity of these factors, he can quickly and readily prove their worth by blocking both the right and left sides of the jaw of the same patient. For example, on the right side, inject the solution in a manner, as outlined above, while on the left side inject a solution that is extremely hot or cold, or a solution which is not isotonic, or, one which does not conform to the laws and principles as given on pages 342, 350, and 351, or inject the solution too rapidly, infiltrating the sphenomaxillary ligament or the internal pterygoid muscle. If this simple test is made by the operator, the result will be conclusive evidence of the need of conforming to every detail of the technic. The patient will be the best judge as to the result and will experience postoperative discomfort on the left side, which was improperly injected.

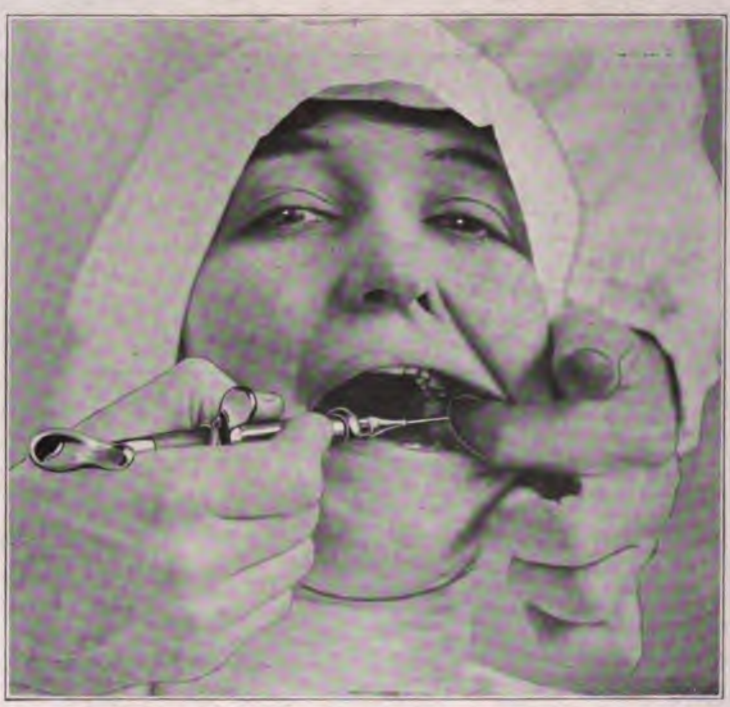

Fig. 392.—Illustrating first position of syringe for blocking the inferior dental-lingual nerves on left side. Approximate depth of needle is 5 millimeters; needle point in contact with periosteum covering internal oblique line.

Curved Needle Contraindicated.—A curved needle is contraindicated for blocking any deep nerve branch, for the reason that it is impossible to know the exact location of the point when it is concealed from view in the tissues. Matas and Allen called attention to this fact several years ago, and stated that it was contraindicated and dangerous, inasmuch as the location of the point of the needle is lost, and there was greater probability of puncturing a blood vessel. There is nothing to be gained by using a bent or curved needle as it is impossible to insert a curved needle between muscles—a fact well known to those who understand anatomy.

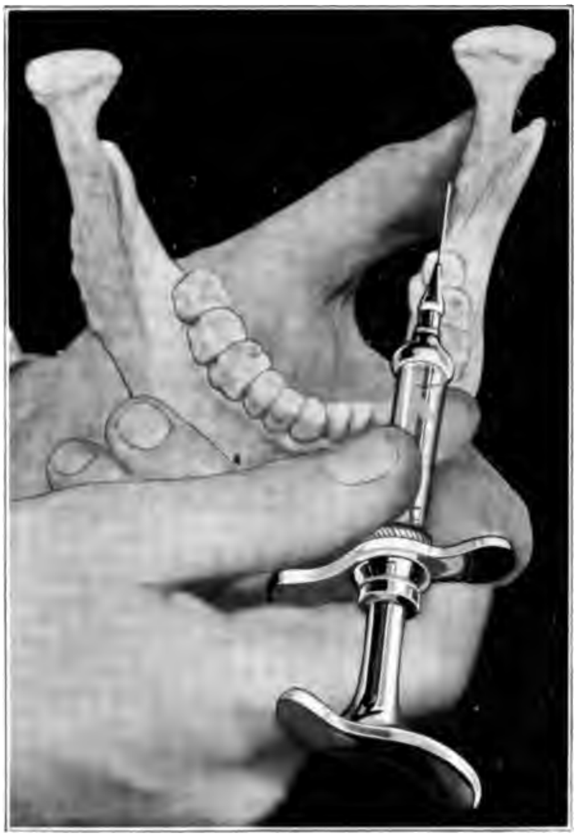

Fig. 393.- Illustrating second position of syringe for blocking lingual nerve on left side. Point of needle is located approximately 5 millimeters medioposteriorly to internal oblique line.

Time to Wait for Anesthesia.—In the average case ten to twenty minutes should elapse for profound anesthesia following the inferior dentolingual injection, the average time being fifteen minutes. The author has, in many cases, been able to extract teeth or perform other oral operations within seven minutes following the inferior dentolingual injection. The time to wait for anesthesia depends on the four factors given on page 196, and the reader is re-

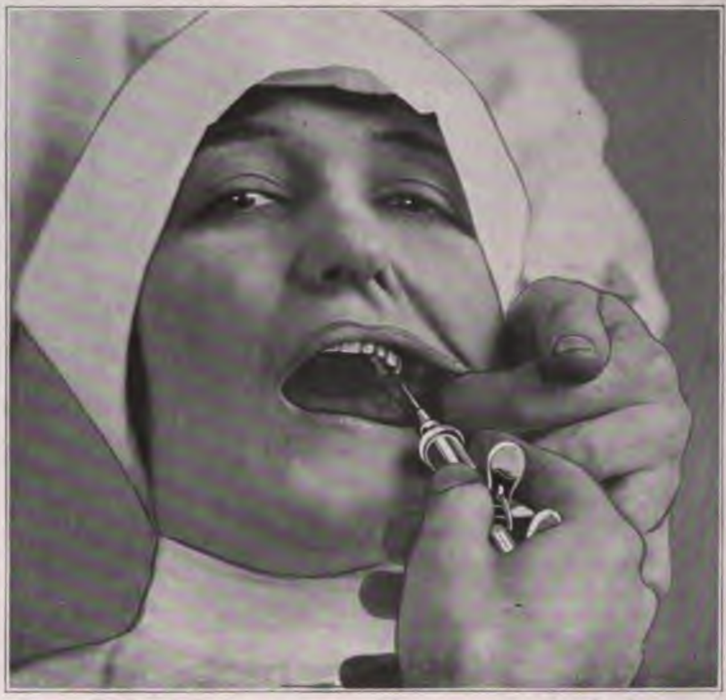

Fig. 394.—Illustrating second position of syringe for blocking inferior dental-lingual nerves on left side. Point of needle is located near lingual nerve at approximate depth of 1 centimeter.

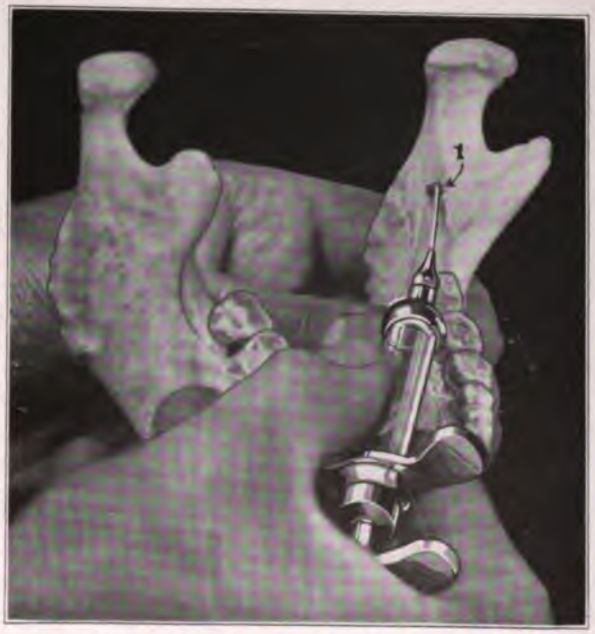

Fig. 395.—Illustrating third position of syringe for blocking inferior dental nerve on left side. Point of needle is in contact with periosteum near inferior dental foramen.

1, Inferior dental foramen.

has its base upward and apex downward, while the other has its base anteriorly with its apex posteriorly. Therefore, the lateral surface of the spheno-maxillary ligament and the internal pterygoid muscle is located nearer the ascending ramus posteriorly than it is anteriorly; when the needle is inserted into the region of the inferior dental nerve, the operator must not lose sight of this fact. A cross section at a point 1 cm. above the occlusal plane of the lower teeth is illustrated in Fig. 379. The solution is injected at this level. The contents of the pterygomandibular region are the inferior dental nerve,

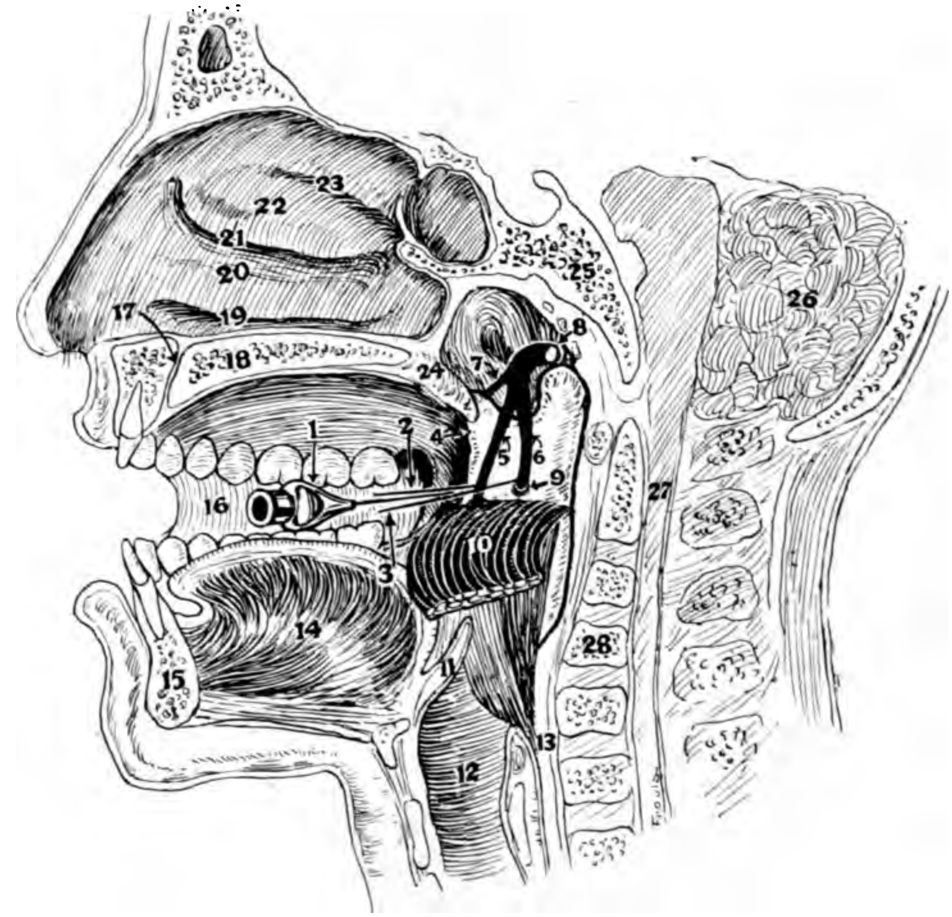

Fig. 389.—Anatomical drawing illustrating the first, second and third positions of needle for blocking the inferior dental-lingual nerves.

1. First position of needle—needle point is in contact with periosteum covering internal oblique line; 2, second position of needle—needle point near lingual nerve; 3, third position of needle—needle point situated near inferior dental nerve; 4, ascending ramus; 5, lingual nerve; 6, inferior dental nerve; 7, long buccal nerve; 8, third or mandibular division; 9, inferior dental foramen; 10, internal pterygoid muscle (cut); 11, epiglottis; 12, trachea; 13, esophagus; 14, median section of tongue; 15, section of mandible in median line; 16, cheek; 17, anterior palatine canal; 18, section of palate bone at median line; 19, inferior turbinate bone; 20, middle meatus; 21, middle turbinate bone; 22, superior meatus; 23, superior turbinate bone; 24, soft palate in median line; 25, sphenoid bone; 26, cerebellum; 27, spinal cord; 28, cervical vertebra.

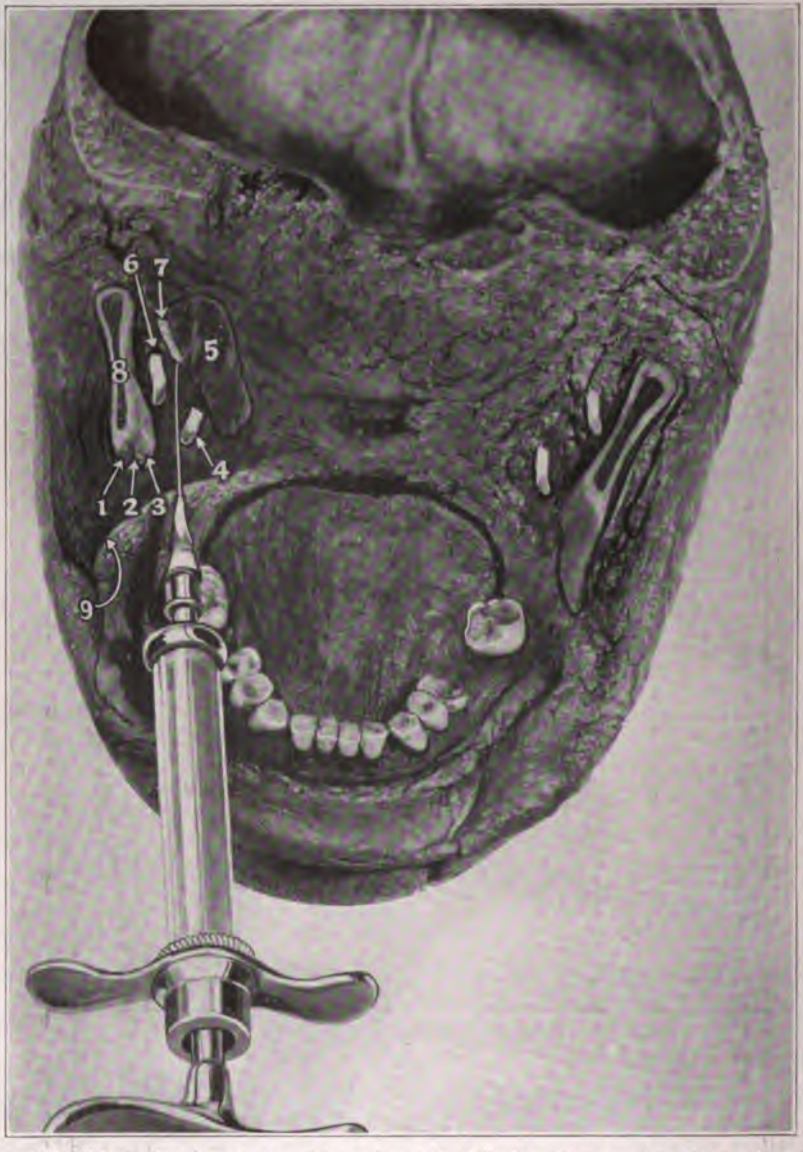

Fig. 397.—Illustrating incorrect position of needle following the second position of syringe for blocking the lingual nerve. Note point of needle in contact with sphenomaxillary ligament and near internal pterygoid muscle.

1. External oblique line; 2, retromolar triangle; 3, internal oblique line; 4, lingual nerve; 5, cross section of internal pterygoid muscle; 6, inferior dental nerve; 7, cross section of sphenomandibular ligament; 8, cross section of ramus of mandible; 9, oral mucous membrane.

If teeth are to be extracted, or a pulp is to be removed, or some other operation of like nature is to be done, profound anesthesia must be secured before attempting to operate, and a sufficient length of time must be given to allow the solution to thoroughly permeate the connective tissue which surrounds the nerve trunk and the nerve fibers themselves. It must also be remembered that the inferior dental and lingual nerves are of considerable size, and a sufficient length of time must be allowed for the solution to reach the central nerve fibers and anesthetize them. The operator should never be guilty of forcing a bur into the pulp chamber of a tooth which

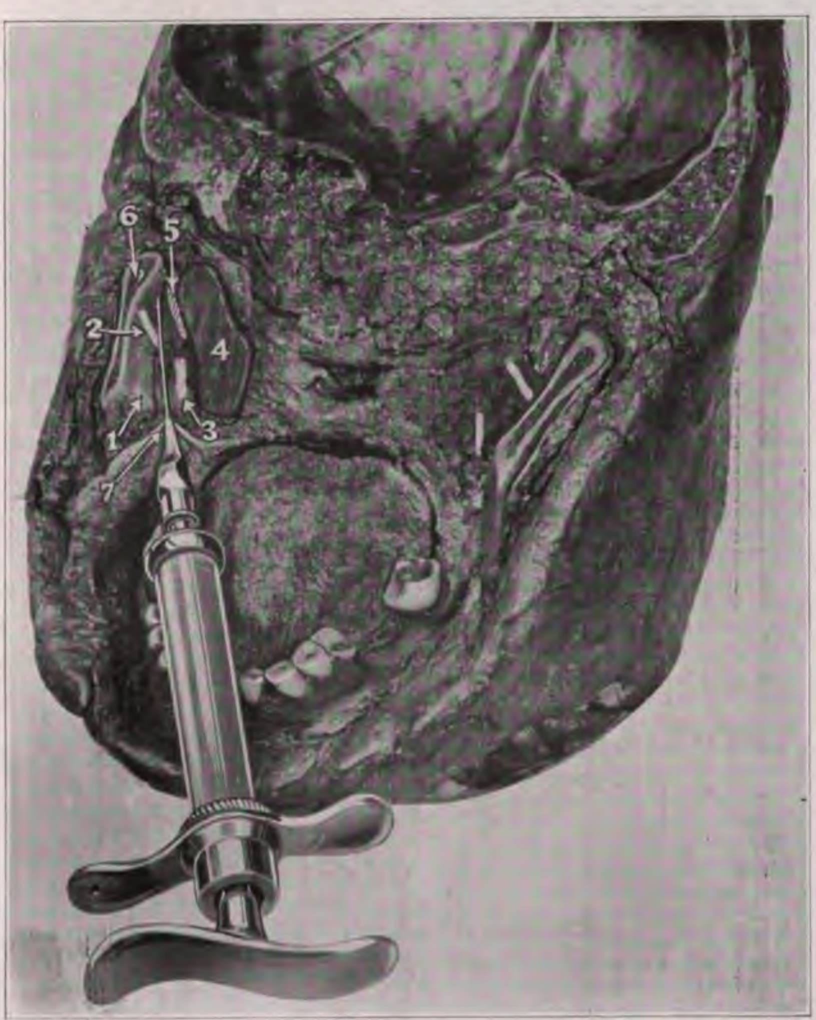

Fig. 398.—Illustrating wrong position of needle which is inserted posterior to inferior dental nerve at the completion of the third position.

1, Internal oblique line; 2, inferior dental nerve; 3, lingual nerve; 4, cross section internal pterygoid muscle; 5, cross section sphenomandibular ligament; 6, cross section of ramus of mandible; 7, hub of needle imbedded in mucous membrane.

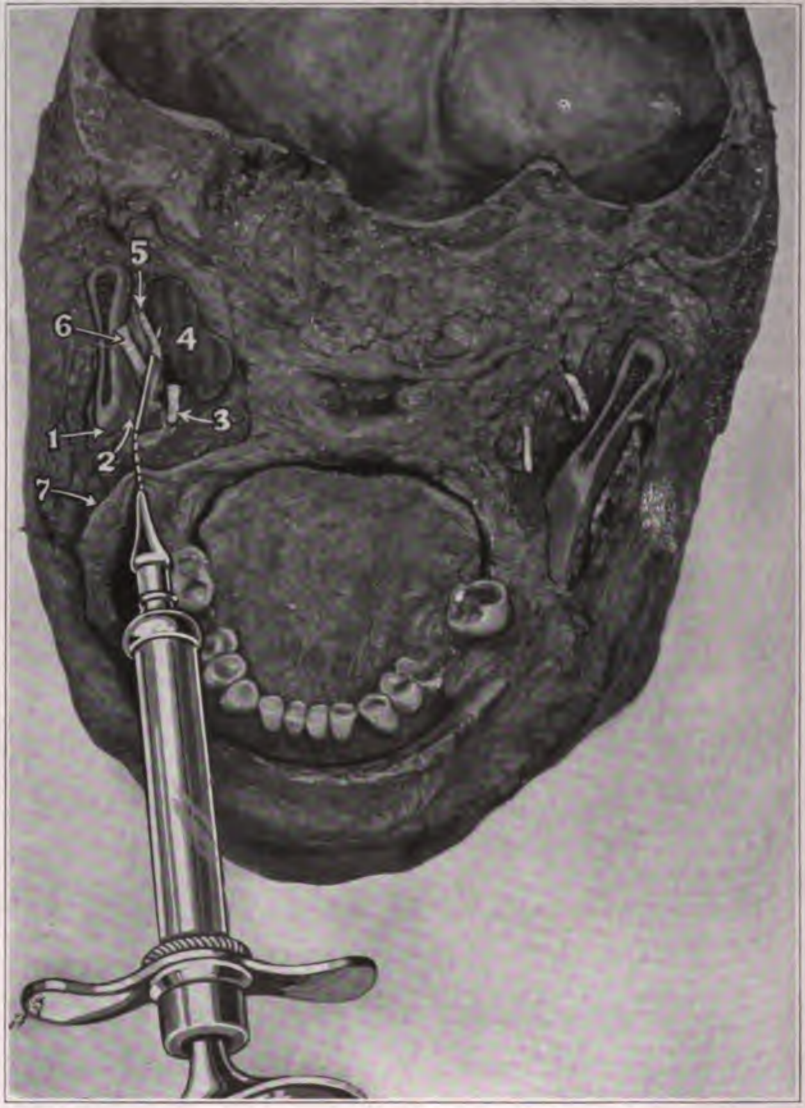

Fig. 399.—Illustrating what may happen if the needle is advanced beneath the periosteum covering the internal oblique line. The needle would bend as the syringe is changed from second to third positions and may pierce the sphenomaxillary ligament and enter the internal pterygoid muscle.

1, External oblique line; 2, internal oblique line; 3, lingual nerve; 4, section of internal pterygoid muscle; 5, section of sphenomandibular ligament; 6, inferior dental nerve; 7, oral mucous membrane.

contains a live pulp, or to extract a tooth unless he is absolutely sure that the part is thoroughly anesthetized. The average time to wait for anesthesia of the inferior dental nerve is fifteen minutes, but when we consider the profound anesthesia which is secured, and the great amount of good that we are rendering our patients, not only from the fact that they appreciate dental services free from pain, but from the fact that the operator can render a much better service to his patient for all classes of operative work, be it cavity preparation, pulp removal, extraction of teeth or other oral operations. We are, therefore, justified and are well repaid in waiting a few minutes for profound anesthesia to take place, and last, but not least, the

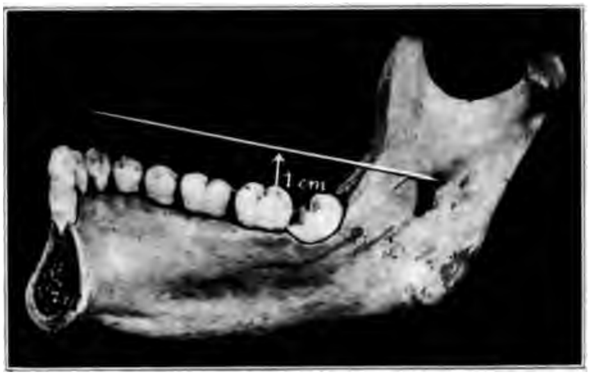

Fig. 400.—Illustrating the relation of the needle to the occlusal plane of lower teeth for blocking inferior dental nerve. The needle is extended backward on a plane 1 centimeter above and parallel to occlusal surface of lower teeth.

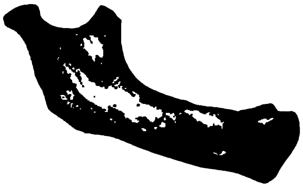

Fig. 401.—Mandible of an infant.

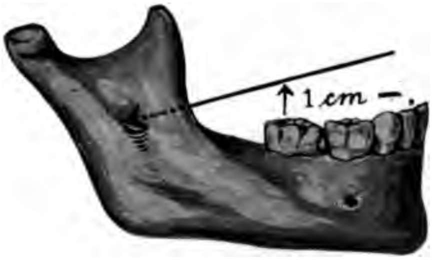

Fig. 402.—Mandible of a child five years old showing direction of needle in blocking the inferior dental nerve.

406.) *If a straight needle which has a short, sharp bevel is employed, it is exceedingly difficult to puncture an artery as an artery is elastic and is surrounded by loose, connective tissue, and has a tendency to pass to one side or the other.* After extended experience the author has not, to his knowledge, ever punctured the inferior dental artery or vein, and is sure that no difficulty will be encountered, provided the bevel of the needle is in contact with the periosteum lateral to the opening of the inferior dental canal, as is shown in Position 3 as illustrated in Figs. 379 and 386.

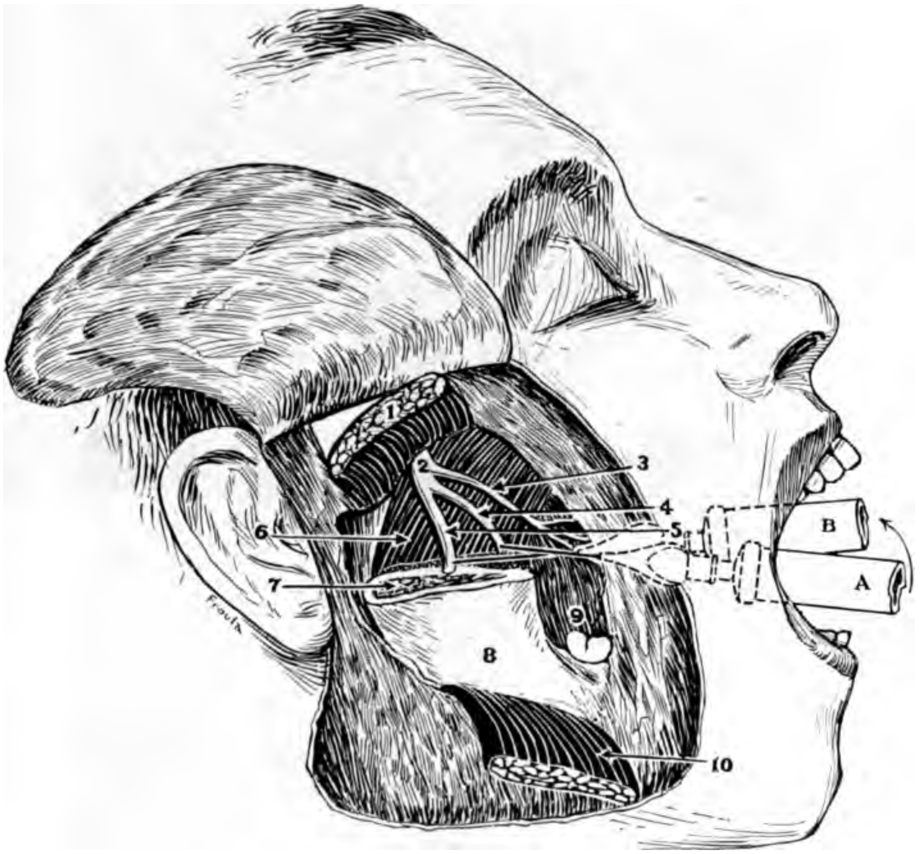

Fig. 388.—Anatomical drawing illustrating the second and third positions of syringe for blocking the inferior dental-lingual nerves.

A. Second position—needle point in contact with lingual nerve.

B. Third position—needle point in contact with periosteum and inferior dental nerve.

1, Cut portion masseter muscle—turned up; 2, mandibular nerve; 3, long buccal nerve; 4, lingual nerve; 5, inferior dental nerve; 6, internal pterygoid muscle; 7, cross section ascending ramus; 8, external surface ascending ramus; 9, lower third molar; 10, masseter muscle—cut.

The Pterygomandibular Region.—The pterygomandibular region is bounded mesially by the lateral surfaces of the sphenomaxillary ligament and internal pterygoid muscle, and laterally by the medial surface of the ascending ramus. (See Fig. 379.) In a way two triangles are formed, one of which

has its base upward and apex downward, while the other has its base anteriorly with its apex posteriorly. Therefore, the lateral surface of the spheno-maxillary ligament and the internal pterygoid muscle is located nearer the ascending ramus posteriorly than it is anteriorly; when the needle is inserted into the region of the inferior dental nerve, the operator must not lose sight of this fact. A cross section at a point 1 cm. above the occlusal plane of the lower teeth is illustrated in Fig. 379. The solution is injected at this level. The contents of the pterygomandibular region are the inferior dental nerve,

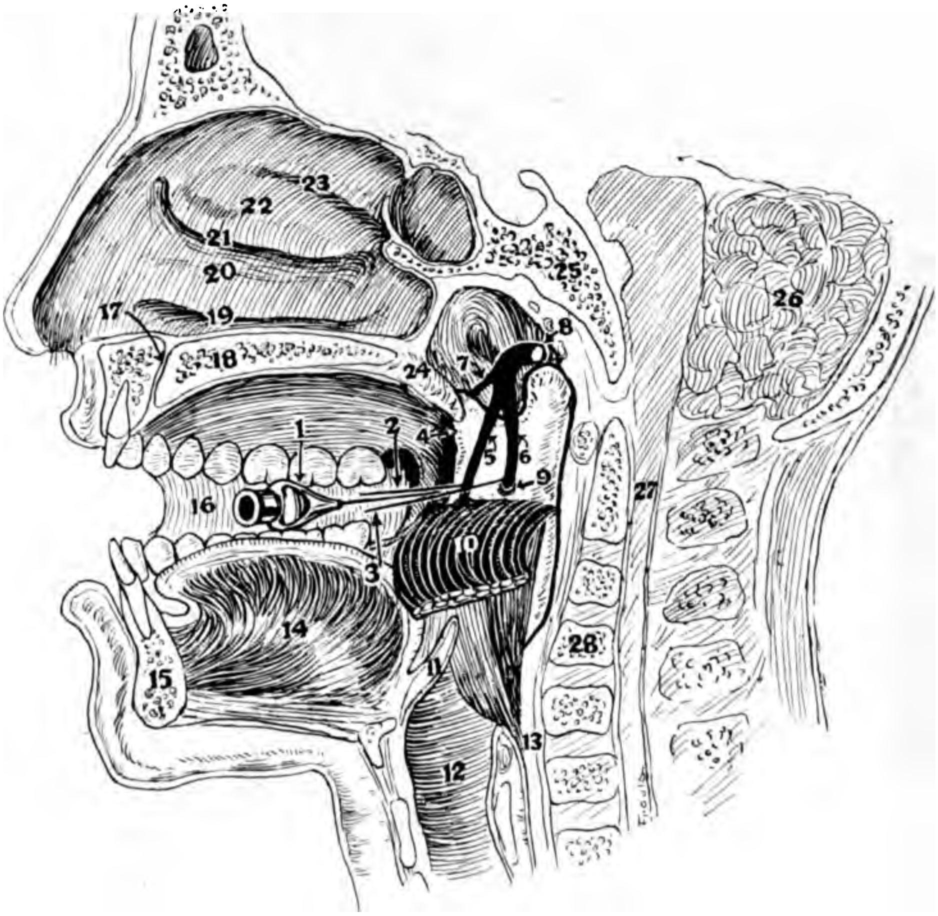

Fig. 389.—Anatomical drawing illustrating the first, second and third positions of needle for blocking the inferior dental-lingual nerves.

1. First position of needle—needle point is in contact with periosteum covering internal oblique line; 2, second position of needle—needle point near lingual nerve; 3, third position of needle—needle point situated near inferior dental nerve; 4, ascending ramus; 5, lingual nerve; 6, inferior dental nerve; 7, long buccal nerve; 8, third or mandibular division; 9, inferior dental foramen; 10, internal pterygoid muscle (cut); 11, epiglottis; 12, trachea; 13, esophagus; 14, median section of tongue; 15, section of mandible in median line; 16, cheek; 17, anterior palatine canal; 18, section of palate bone at median line; 19, inferior turbinate bone; 20, middle meatus; 21, middle turbinate bone; 22, superior meatus; 23, superior turbinate bone; 24, soft palate in median line; 25, sphenoid bone; 26, cerebellum; 27, spinal cord; 28, cervical vertebra.

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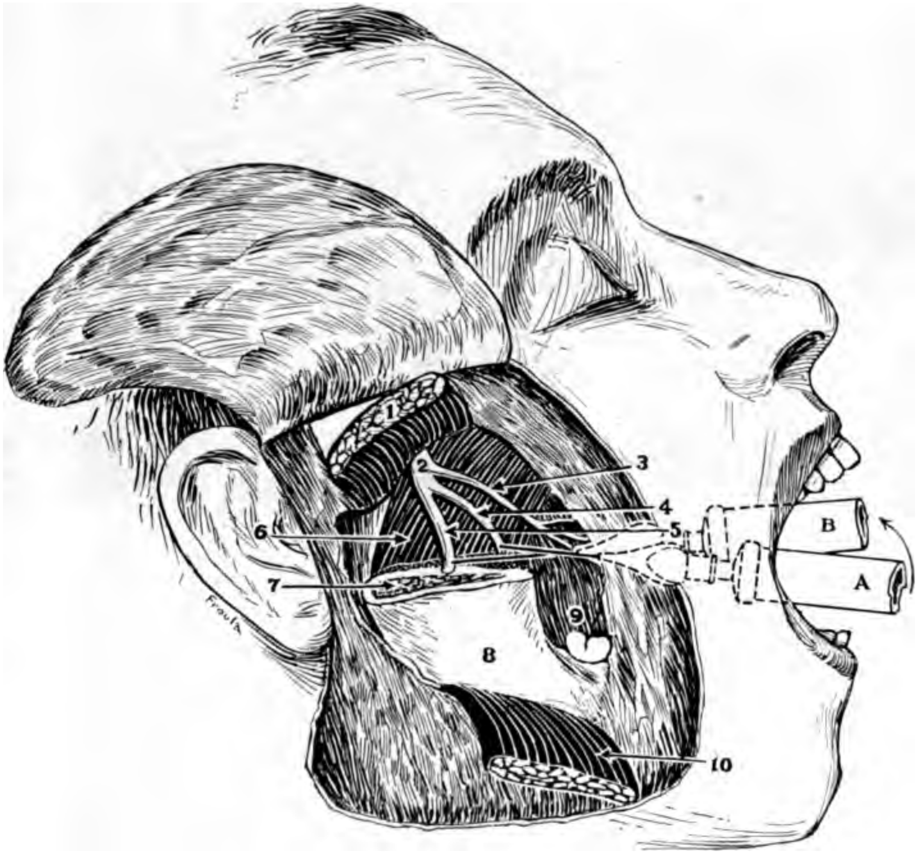

Fig. 388.—Anatomical drawing illustrating the second and third positions of syringe for blocking the inferior dental-lingual nerves.

A. Second position—needle point in contact with lingual nerve.

B. Third position—needle point in contact with periosteum and inferior dental nerve.

1, Cut portion masseter muscle—turned up; 2, mandibular nerve; 3, long buccal nerve; 4, lingual nerve; 5, inferior dental nerve; 6, internal pterygoid muscle; 7, cross section ascending ramus; 8, external surface ascending ramus; 9, lower third molar; 10, masseter muscle—cut.

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has its base upward and apex downward, while the other has its base anteriorly with its apex posteriorly. Therefore, the lateral surface of the spheno-maxillary ligament and the internal pterygoid muscle is located nearer the ascending ramus posteriorly than it is anteriorly; when the needle is inserted into the region of the inferior dental nerve, the operator must not lose sight of this fact. A cross section at a point 1 cm. above the occlusal plane of the lower teeth is illustrated in Fig. 379. The solution is injected at this level. The contents of the pterygomandibular region are the inferior dental nerve,

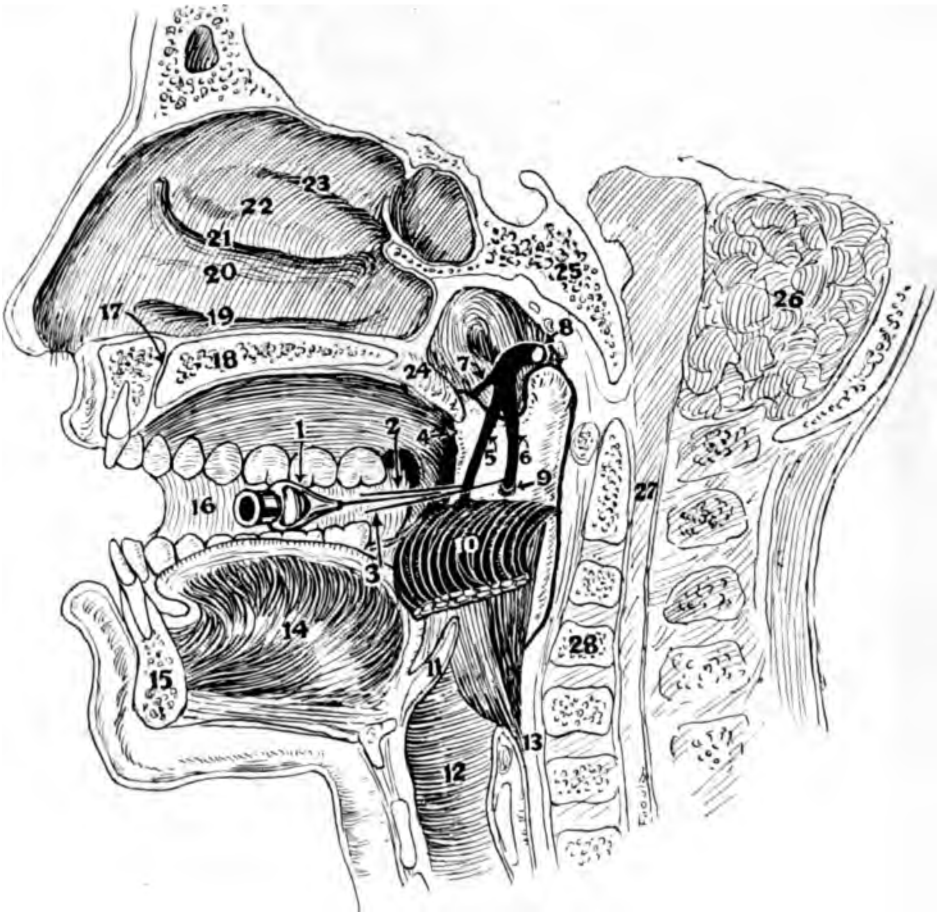

Fig. 389.—Anatomical drawing illustrating the first, second and third positions of needle for blocking the inferior dental-lingual nerves.

1. First position of needle—needle point is in contact with periosteum covering internal oblique line; 2, second position of needle—needle point near lingual nerve; 3, third position of needle—needle point situated near inferior dental nerve; 4, ascending ramus; 5, lingual nerve; 6, inferior dental nerve; 7, long buccal nerve; 8, third or mandibular division; 9, inferior dental foramen; 10, internal pterygoid muscle (cut); 11, epiglottis; 12, trachea; 13, esophagus; 14, median section of tongue; 15, section of mandible in median line; 16, cheek; 17, anterior palatine canal; 18, section of palate bone at median line; 19, inferior turbinate bone; 20, middle meatus; 21, middle turbinate bone; 22, superior meatus; 23, superior turbinate bone; 24, soft palate in median line; 25, sphenoid bone; 26, cerebellum; 27, spinal cord; 28, cervical vertebra.

artery and vein, lingual nerve, artery and vein, adipose and loose connective tissues. These loose connective and adipose tissues readily absorb the solution when injected for the lingual and inferior dental block. It is in the pterygomandibular region that the solution is injected, and not beneath the periosteum or into the sphenomaxillary ligament or internal pterygoid muscle. (See Fig. 407.)

Location of the Internal Oblique Line of the Ascending Ramus.—The location of the internal oblique line is rather misleading to many operators and the misjudging of its location has been the result of many failures in the blocking of the inferior dentolingual nerves. During the author's experience he has in a number of cases observed the operator starting the needle at a point too near the median line, instead of that illustrated in Figs. 375 and 376, while the syringe is in the first position. The exact location of the internal oblique line must be determined by careful palpation, and it is highly important that it be located before making the initial puncture. The prominence of this bony landmark varies a great deal with different individuals, in some of whom it is almost missing, while in others it is well developed even to the extent that it may give the operator some difficulty in advancing the needle. In case it is extremely prominent, the needle must be carried more medially.

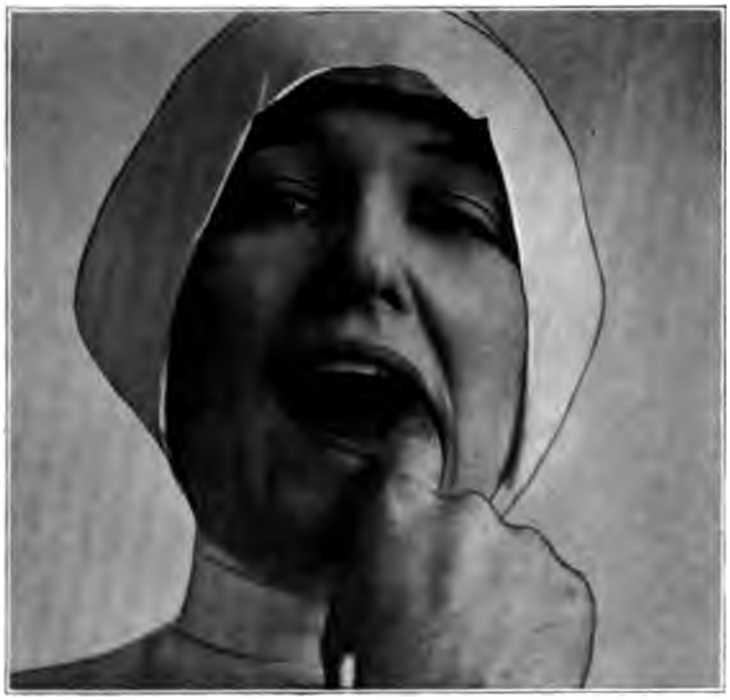

Fig. 390. Locating the external and internal oblique lines and retromolar fossa with tip of right index finger on left side.

Without reviewing their osteology, most operators are under the impression that the anterior portion of the internal oblique line is located directly posterior to the lower third molar, but if the osteology is studied, it will be found that the internal oblique line is located laterally to an anteroposterior line drawn along the buccal surfaces of the lower teeth. (See Fig. 379.) In many instances the author has been told by those observing the technic, that they were surprised to see how far laterally the needle was inserted into the tissue, or that they were under the impression that the point of the needle was inserted into the mucosa directly posterior to the lower third molar. This common mistake can not be emphasized too strongly, as many operators have inserted the needle too far lingually to the internal oblique line, which has resulted in infiltrating the internal pterygoid muscle, sphenomaxillary ligament, thus causing postoperative pain. If the solution is injected in accordance with Positions 2 and 3 the muscle and ligament will not be infiltrated, and no discomfort will follow the injection.

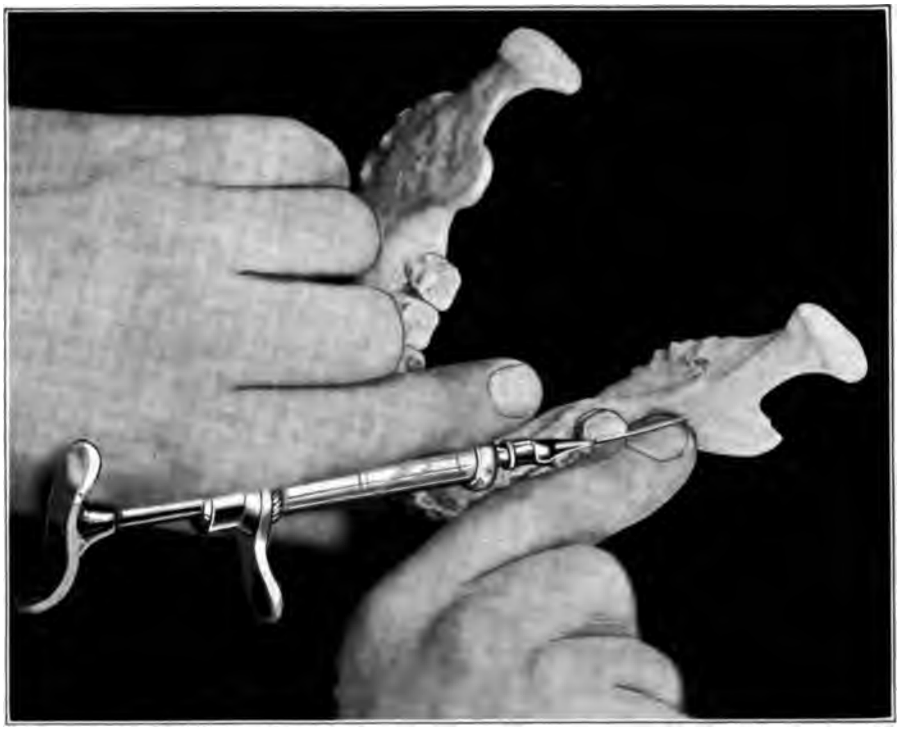

Fig. 391.—Illustrating first position of syringe for blocking inferior dental-lingual nerves on left side. The point of needle is in contact with the periosteum covering internal oblique line.

Postoperative Pain Caused by Improperly Injected Solution.—It is well to remember that the delicate tissues which fill the pterygomandibular region are very sensitive and respond to the slightest trauma; also, that infiltration of the pterygoid muscle or sphenomaxillary ligament, will cause postoperative discomfort or pain, from the fact that the internal pterygoid muscle is constantly undergoing contraction and relaxation during the movement of the mandible while talking or masticating. A patient will notice any slight deviation from the normal more readily in this region than in any other by the block method. The reason for this is that the tissues are susceptible to trauma. Great importance must also be attached to the fact that the solution should be injected while the point of the needle is located near the periosteum in the region of the inferior dental foramen; the solution should be slowly injected and be near body temperature. If the operator questions the necessity of these factors, he can quickly and readily prove their worth by blocking both the right and left sides of the jaw of the same patient. For example, on the right side, inject the solution in a manner, as outlined above, while on the left side inject a solution that is extremely hot or cold, or a solution which is not isotonic, or, one which does not conform to the laws and principles as given on pages 342, 350, and 351, or inject the solution too rapidly, infiltrating the sphenomaxillary ligament or the internal pterygoid muscle. If this simple test is made by the operator, the result will be conclusive evidence of the need of conforming to every detail of the technic. The patient will be the best judge as to the result and will experience postoperative discomfort on the left side, which was improperly injected.

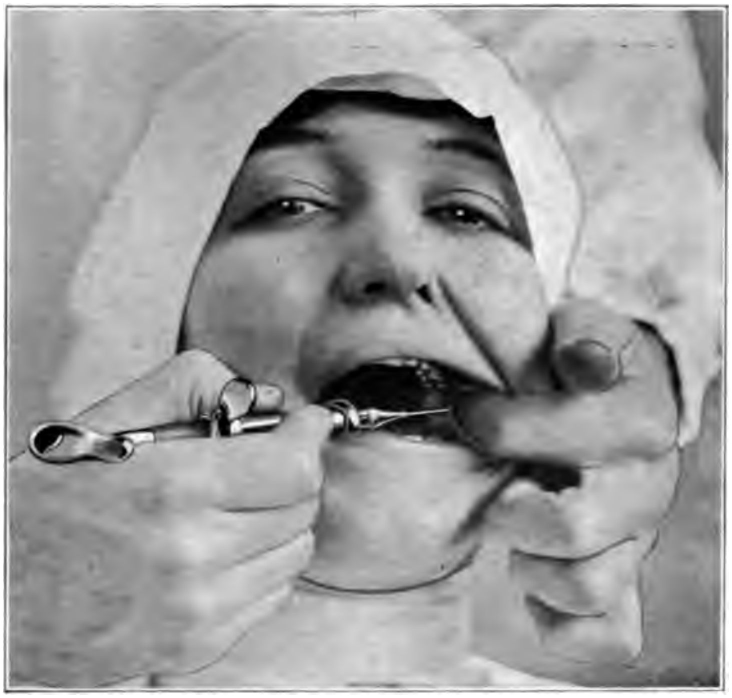

Fig. 392.—Illustrating first position of syringe for blocking the inferior dental-lingual nerves on left side. Approximate depth of needle is 5 millimeters; needle point in contact with periosteum covering internal oblique line.

Curved Needle Contraindicated.—A curved needle is contraindicated for blocking any deep nerve branch, for the reason that it is impossible to know the exact location of the point when it is concealed from view in the tissues. Matas and Allen called attention to this fact several years ago, and stated that it was contraindicated and dangerous, inasmuch as the location of the point of the needle is lost, and there was greater probability of puncturing a blood vessel. There is nothing to be gained by using a bent or curved needle as it is impossible to insert a curved needle between muscles—a fact well known to those who understand anatomy.

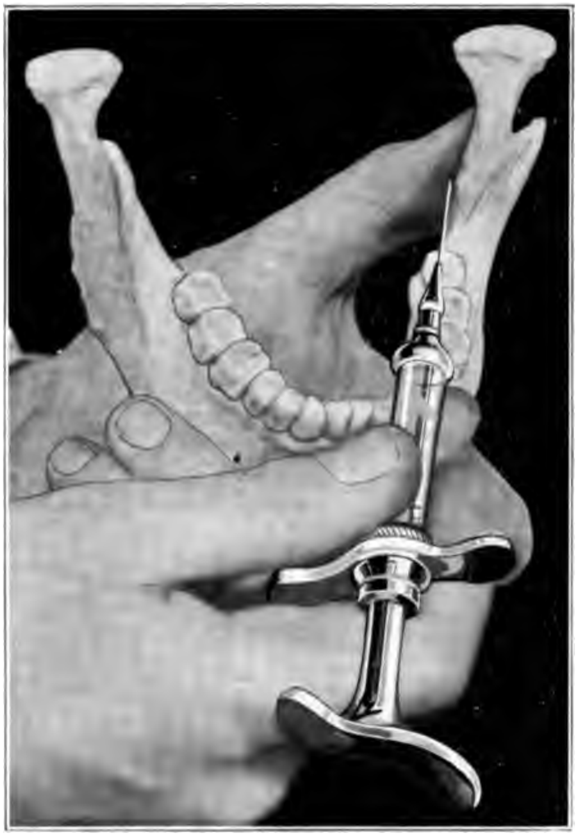

Fig. 393.--Illustrating second position of syringe for blocking lingual nerve on left side. Point of needle is located approximately 5 millimeters medioposteriorly to internal oblique line.

Time to Wait for Anesthesia.—In the average case ten to twenty minutes should elapse for profound anesthesia following the inferior dentolingual injection, the average time being fifteen minutes. The author has, in many cases, been able to extract teeth or perform other oral operations within seven minutes following the inferior dentolingual injection. The time to wait for anesthesia depends on the four factors given on page 196, and the reader is re-

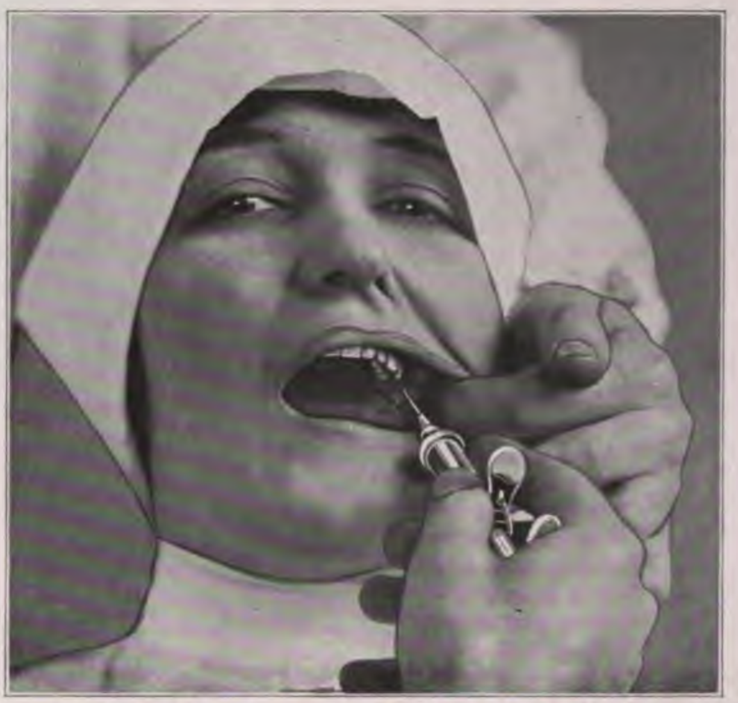

Fig. 394.—Illustrating second position of syringe for blocking inferior dental-lingual nerves on left side. Point of needle is located near lingual nerve at approximate depth of 1 centimeter.

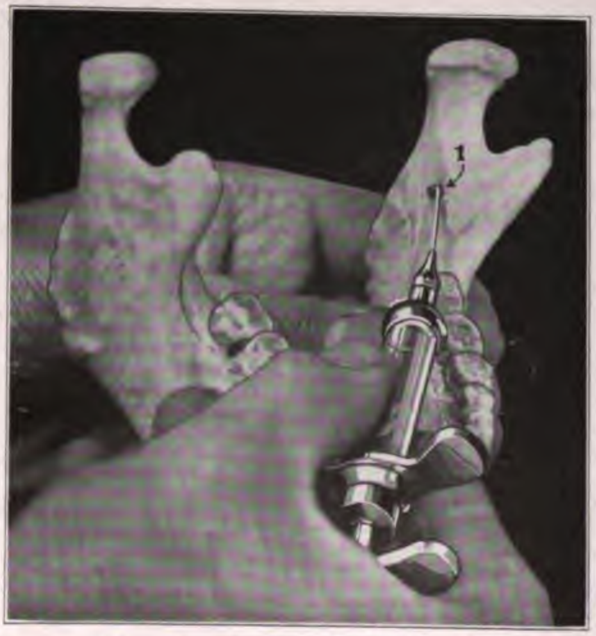

Fig. 395.—Illustrating third position of syringe for blocking inferior dental nerve on left side. Point of needle is in contact with periosteum near inferior dental foramen.

1, Inferior dental foramen.

quested to review this part of the text. The operation should never be started if the patient experiences pain.

Little or no time should be lost between the period of making the injection and the time of resorting to operative dentistry. If the injection is made as soon as the patient is seated in the chair, and if the nature of the operation is such as cavity preparation, the operator may proceed within a few minutes to break in the overhanging enamel walls or carefully excavate the decayed debris. This part of the operation will not produce pain, even though anesthesia is not present, and by beginning the operation in this manner it will save the operator time while the anesthesia is becoming deeper. The rubber dam may be adjusted and all the preliminary steps accomplished which, of course, may be done immediately following the injection. When block anesthesia is employed for cavity preparation, treatment of pyorrhea alveolaris, or the shaping of crowns for bridge abutments, profound anesthesia may not be necessary; therefore, the operator can start operating a short time after the injection is made, and as long as the patient does not experience pain he can cautiously proceed. The operator may inform his patient that he will proceed to operate, and should pain be experienced, to inform him, and then allow a few minutes to elapse before proceeding with the operation.

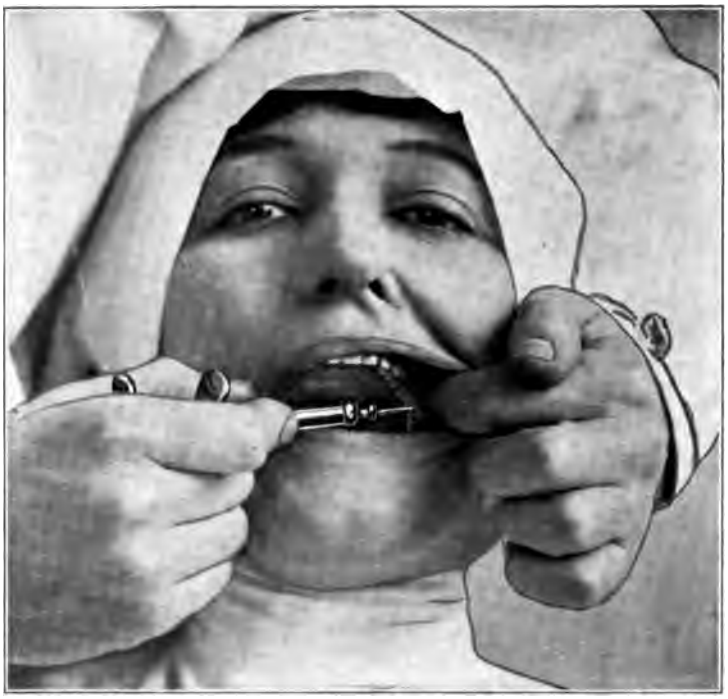

Fig. 396.—Illustrating third position of syringe for blocking inferior dental nerve on left side. Point of needle is in contact with periosteum in region of inferior dental nerve. Approximate depth of needle is 2 centimeters.

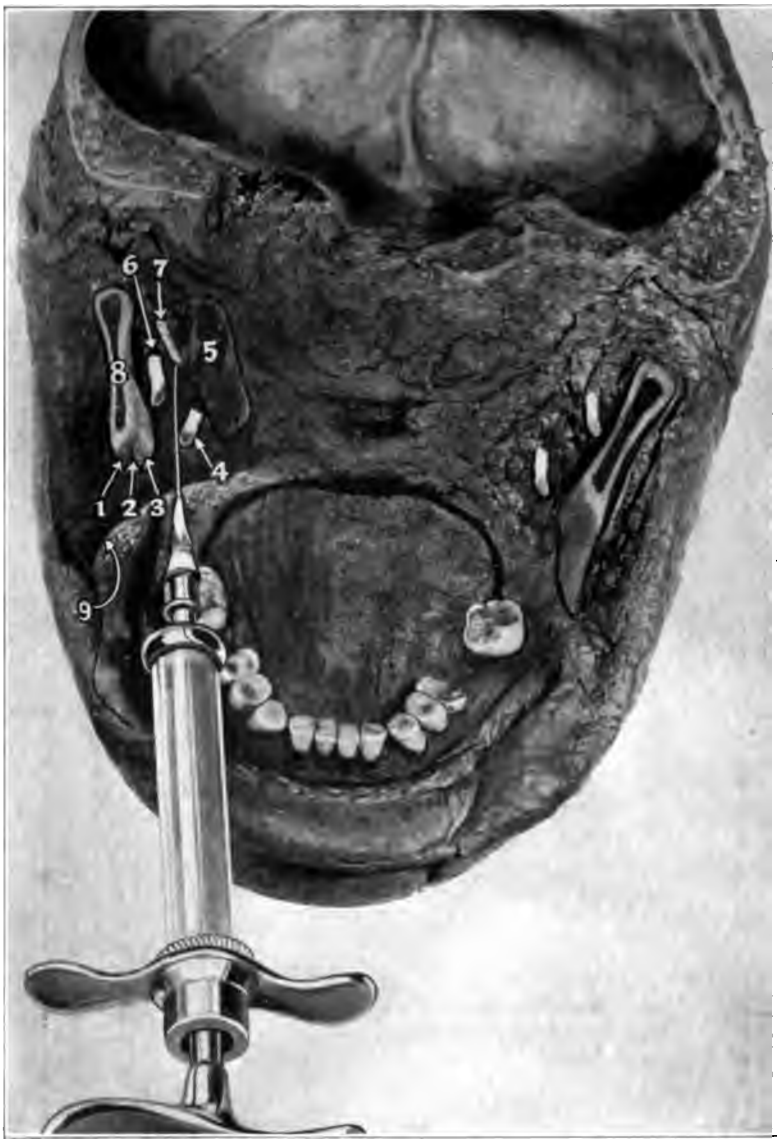

Fig. 397. Illustrating incorrect position of needle following the second position of syringe for blocking the lingual nerve. Note point of needle in contact with sphenomaxillary ligament and near internal pterygoid muscle.

1. External oblique line; 2, retromolar triangle; 3, internal oblique line; 4, lingual nerve; 5, cross section of internal pterygoid muscle; 6, inferior dental nerve; 7, cross section of sphenomandibular ligament; 8, cross section of ramus of mandible; 9, oral mucous membrane.

If teeth are to be extracted, or a pulp is to be removed, or some other operation of like nature is to be done, profound anesthesia must be secured before attempting to operate, and a sufficient length of time must be given to allow the solution to thoroughly permeate the connective tissue which surrounds the nerve trunk and the nerve fibers themselves. It must also be remembered that the inferior dental and lingual nerves are of considerable size, and a sufficient length of time must be allowed for the solution to reach the central nerve fibers and anesthetize them. The operator should never be guilty of forcing a bur into the pulp chamber of a tooth which

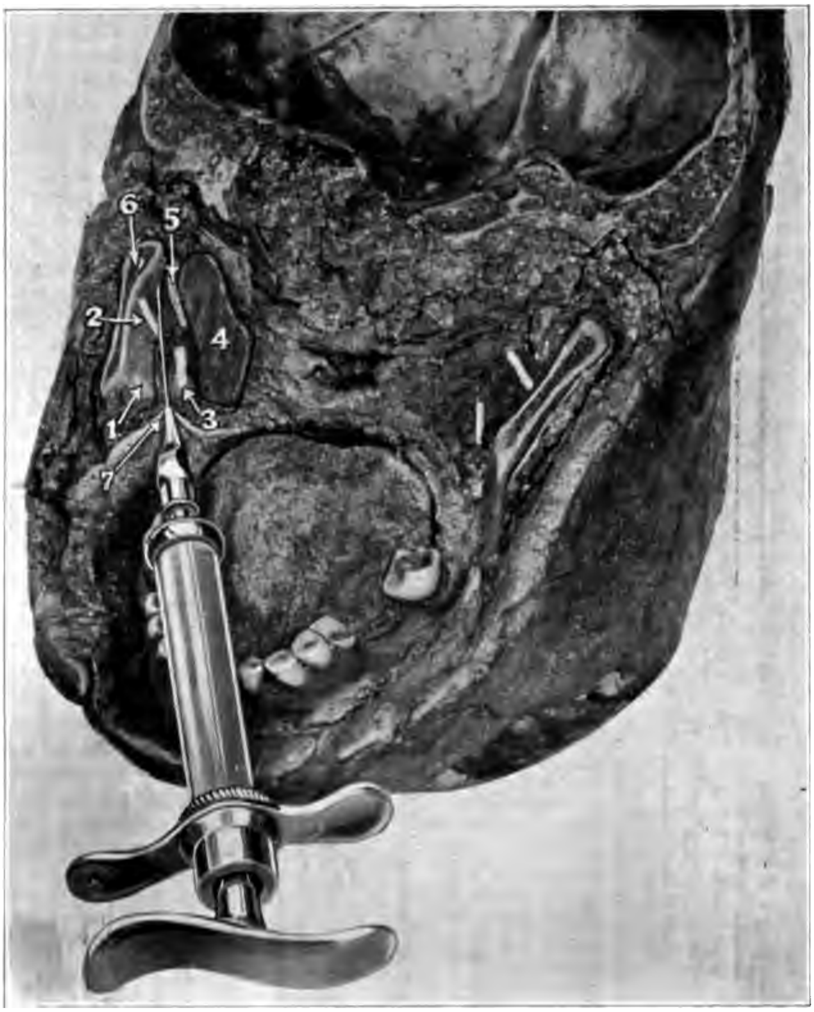

Fig. 398.—Illustrating wrong position of needle which is inserted posterior to inferior dental nerve at the completion of the third position.

1, Internal oblique line; 2, inferior dental nerve; 3, lingual nerve; 4, cross section internal pterygoid muscle; 5, cross section sphenomandibular ligament; 6, cross section of ramus of mandible; 7, hub of needle imbedded in mucous membrane.

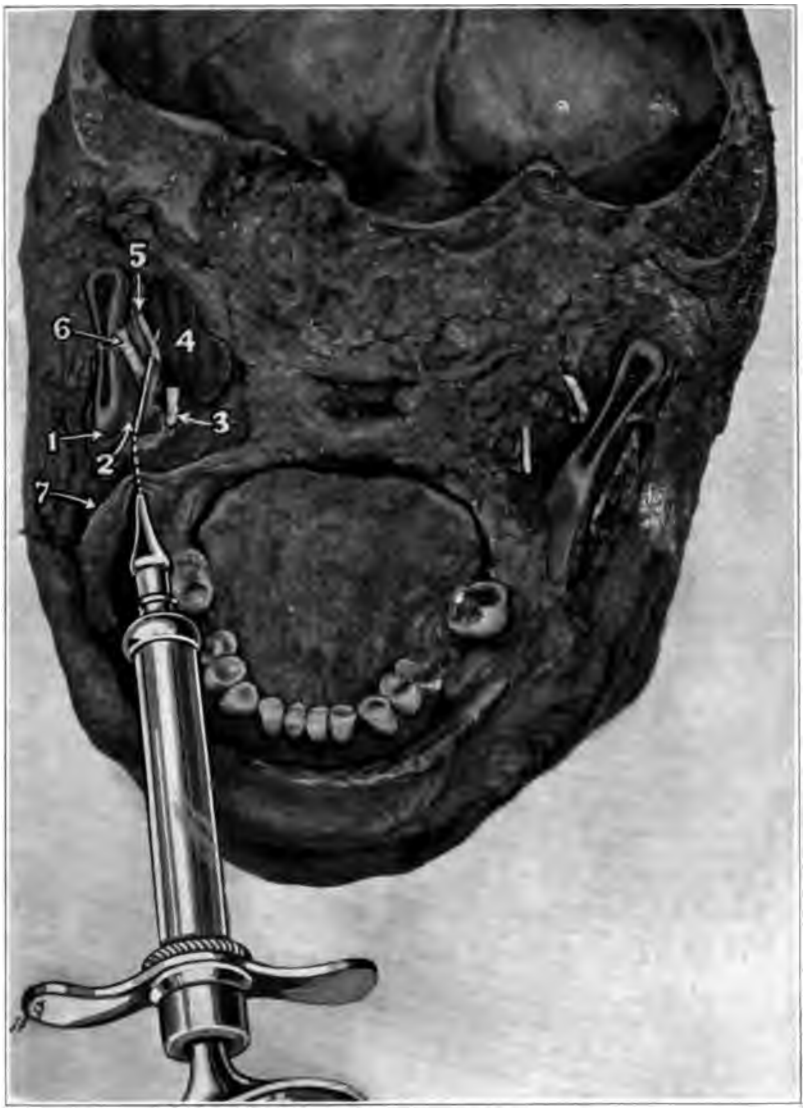

Fig. 399.—Illustrating what may happen if the needle is advanced beneath the periosteum covering the internal oblique line. The needle would bend as the syringe is changed from second to third positions and may pierce the sphenomaxillary ligament and enter the internal pterygoid muscle.

1, External oblique line; 2, internal oblique line; 3, lingual nerve; 4, section of internal pterygoid muscle; 5, section of sphenomandibular ligament; 6, inferior dental nerve; 7, oral mucous membrane.

contains a live pulp, or to extract a tooth unless he is absolutely sure that the part is thoroughly anesthetized. The average time to wait for anesthesia of the inferior dental nerve is fifteen minutes, but when we consider the profound anesthesia which is secured, and the great amount of good that we are rendering our patients, not only from the fact that they appreciate dental services free from pain, but from the fact that the operator can render a much better service to his patient for all classes of operative work, be it cavity preparation, pulp removal, extraction of teeth or other oral operations. We are, therefore, justified and are well repaid in waiting a few minutes for profound anesthesia to take place, and last, but not least, the

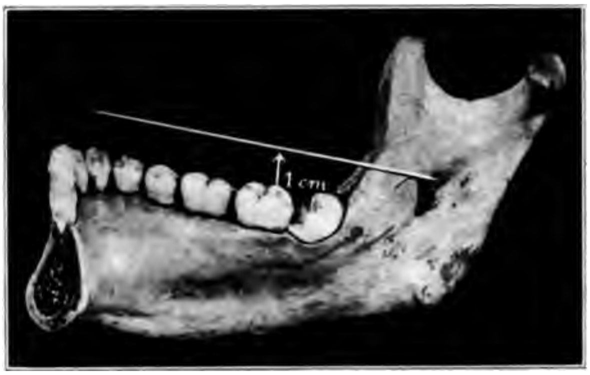

Fig. 400.—Illustrating the relation of the needle to the occlusal plane of lower teeth for blocking inferior dental nerve. The needle is extended backward on a plane 1 centimeter above and parallel to occlusal surface of lower teeth.

Fig. 401.—Mandible of an infant.

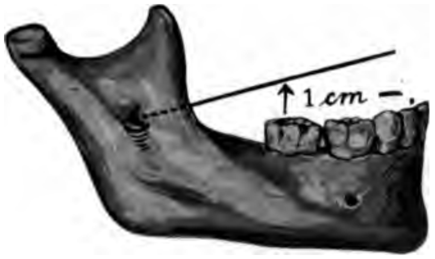

Fig. 402.—Mandible of a child five years old showing direction of needle in blocking the inferior dental nerve.

operator will save much time in completing the operative work after the area is blocked, in comparison to the time required to operate upon the teeth or other parts involved, which are not anesthetized.

BLOCKING THE INFERIOR DENTAL AND LINGUAL NERVES SEPARATELY

The lingual nerve is blocked, using the same technic as given under Positions 1 and 2 of the syringe. It is advantageous to the operator to allow the point of the needle to strike the inner oblique line, as shown in Figs. 375 and 376, and described under the first position of the syringe. This gives the exact location of the needle. Then change the syringe and needle from Position 1 to Position 2, as illustrated by Figs. 380 and 382. From one-

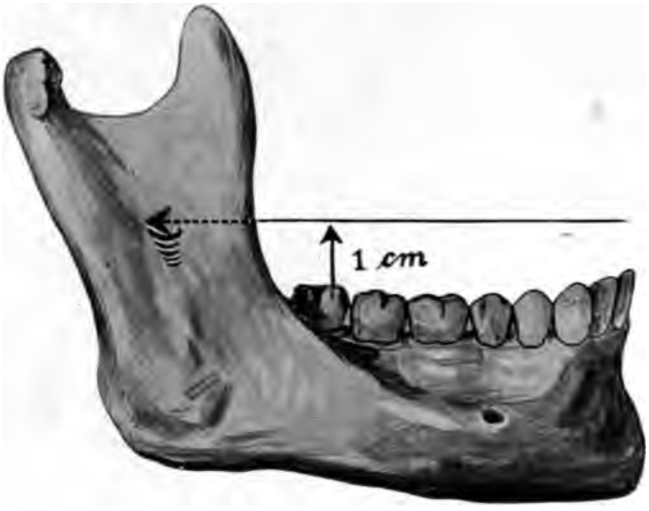

Fig. 403.—Mandible of middle age showing direction of needle in blocking the inferior dental nerve. Needle is advanced backward parallel to occlusal surface of lower teeth.

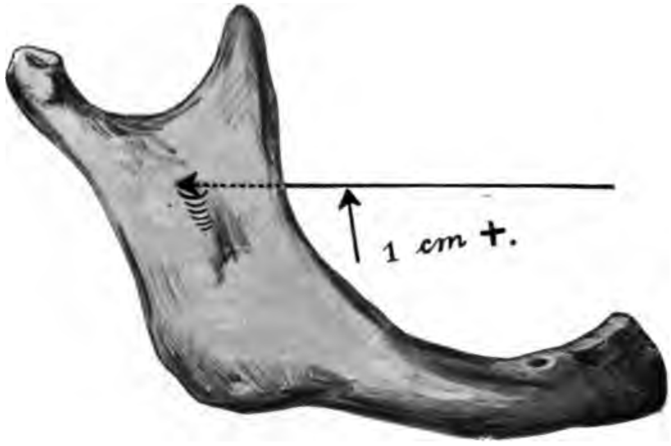

Fig. 404.—Mandible of old age showing direction of needle in blocking the inferior dental nerve.

half to one mil of the solution is slowly injected in the region of the lingual nerve, and in the average case will produce anesthesia within five to seven minutes of the anterior two-thirds of the tongue, mucous membrane in the floor of the mouth, lingual gum tissue and periosteum, as far anteriorly as the lingual surface of the lower cuspid tooth. In many cases it is not possible to operate anterior to the cuspid, on the lingual side, because the branches from the lingual nerve on the opposite side cross the median line and supply the soft tissues to the lingual of the central and lateral. The branches, overlapping each other, are shown in Figs. 98 and 99. Blocking the lingual nerve alone is an uncommon procedure, as in most cases it is blocked in conjunction with the inferior dental nerve. However, in some cases the blocking of the lingual nerve is advantageous, as for operations involving the soft tissues in the floor of the mouth, such as for the removal of an epulis, cyst or ranula.

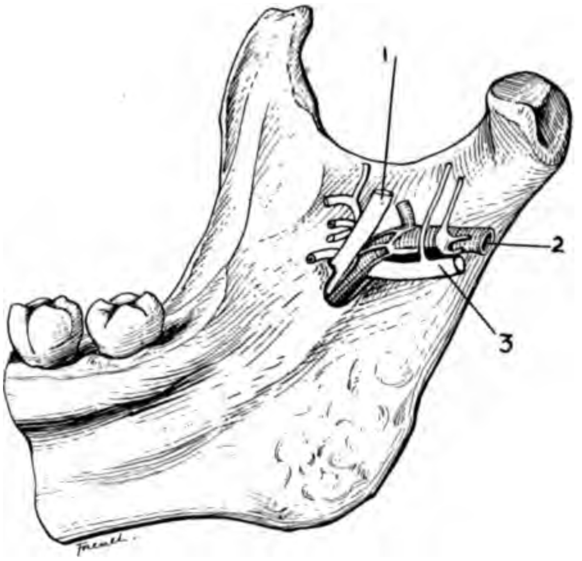

Fig. 405. Inner surface of ascending ramus showing inferior dental nerve, artery and vein entering inferior dental foramen.
1, Inferior dental nerve; 2, inferior dental vein; 3, inferior dental artery.

Blocking the inferior dental nerve alone is a very common procedure, inasmuch as it suffices for operations, such as cavity preparation, pulp removal, shaping of the crowns of teeth for bridge abutments, or for any other operation which does not involve the lingual tissue. The technic for blocking the inferior dental nerve, without the lingual nerve, is identical with that which has already been described, with the exception that during the three movements of the syringe the solution is not deposited at the lingual nerve. It is much better for the operator to carry out the three movements of the syringe, as already given. Many operators make the mistake of blocking the lingual nerve along with the inferior dental for such operations as come under the head of operative dentistry, or for operations that do not involve the lingual tissue. It must be remembered that the lingual nerve has nothing to do with the nerve supply of the teeth, labial or buccal structures, and when these tissues are to be operated upon, it is useless to block the lingual nerve.

Structures Anesthetized.—When the inferior dental and lingual nerves are blocked, anesthesia of a very large area is secured. (See below.)

The Inferior Dental Nerve Block; Anesthesia Secured.—The blocking of the inferior dental nerve produces anesthesia of the lower first and second bicuspids, first, second and third lower molars, and in 50 per cent of the cases, the cuspid and partial anesthesia of the lateral incisor. In addition, the alveolar process, buccal periosteum, gum tissue, mucous membrane on the buccal side as far anteriorly as the cuspid, are anesthetized. In some cases anesthesia may extend as near the median line as the labial surface of the lower lateral incisor, and in some instances anesthesia of the tooth may be secured. In addition to the alveolar process, the greater portion of the body of the mandible on the side of injection is blocked. (See Fig. 408.) The extent of anesthesia secured in the lower cuspid, lateral and central incisor teeth, or the tis-

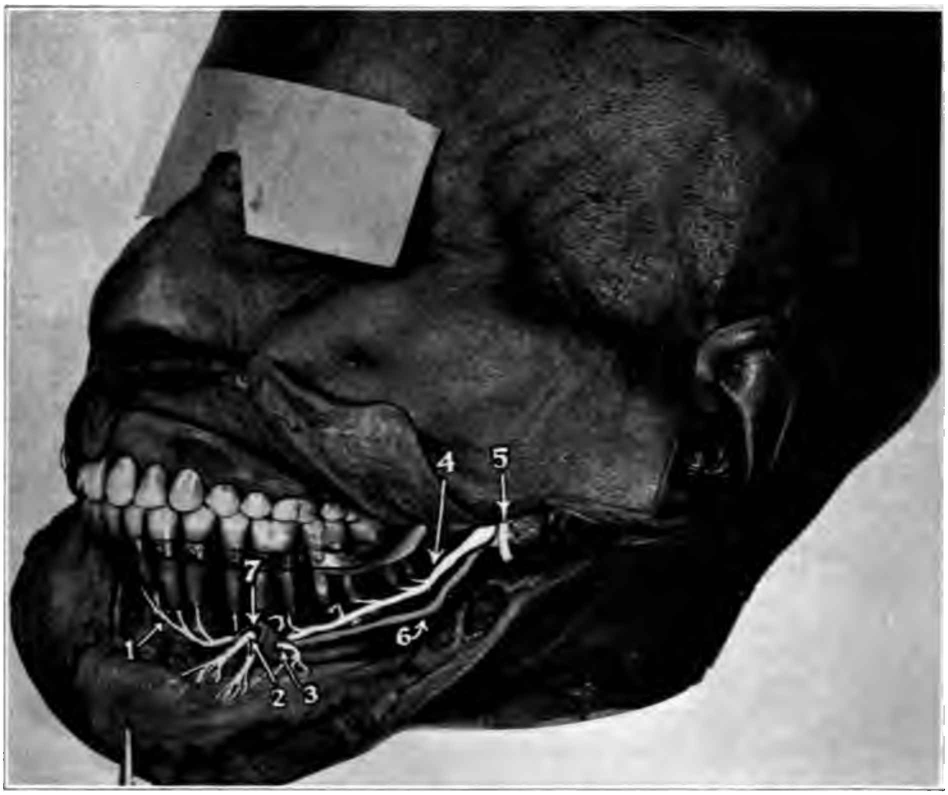

Fig. 406.—Dissected wet anatomical specimen showing the following structures:
1, Incisive nerves; 2, 3, mental nerves; 4, inferior dental nerves; 5, inferior dental vein (cut); 6, inferior dental artery; 7, mental foramen.

sues near the median line, depends on the interlacing or overlapping nerve branches from the opposite side. In many instances the four lower and in some cases the six anterior teeth, alveolar process and labial structures are supplied by branches from both the right and left inferior dental nerves. Therefore, with a rich nerve supply from two different sources, it is impossible to prepare hypersensitive gingival cavities in the cuspid, lateral or central incisors, or remove the dental pulp without making an additional injection to block the nerve branches which cross the median line from the opposite side. In addition to blocking the inferior dental nerve, it is necessary, in at least 75 per cent of cases, to block the long buccal nerve supplying the gum tissue, mucosa, and periosteum buccal and distal of the lower second and third molars, in addition to the inferior dental for surgical procedures involving the second and third molars, alveolar process and buccal tissues.

The Lingual Nerve Block; Anesthesia Secured.—The blocking of the lingual nerve produces anesthesia in the mucosa and connective tissue in the floor of the mouth, the gum tissue and periosteum situated to the lingual of the lower molars, bicuspids and cuspid, and in some cases the region of the lateral incisor, together with the anterior two-thirds of the tongue. (See Figs. 60 and 99.) It is unnecessary to block the lingual nerve for operative dentistry, but if the teeth are to be extracted or the lingual tissues are involved in the operation, then it is essential to block the lingual, either in conjunction with or without the inferior dental blocking, this depending on the nature of the operation.

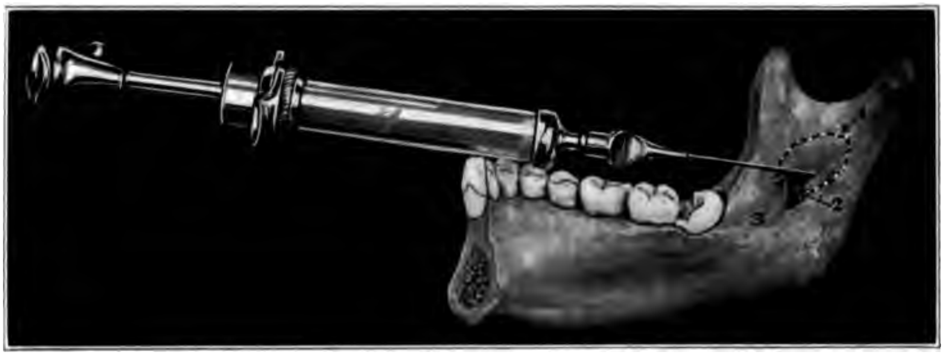

Fig. 407.—1, Mandibular sulcus; 2, inferior dental foramen and 3, lingula. Dotted outline shows area of diffusion of solution in region of inferior dental nerve.

Blocking the Interlacing or Overlapping Branches.—The blocking of the interlacing or overlapping branches is highly important following the inferior dentolingual injection, and if the nervous anatomy is understood by the operator, he will experience little difficulty in producing profound anesthesia of any part supplied by the inferior dental and lingual nerves. It has been stated under "Structures Anesthetized," that the blocking of the inferior dental nerve produces anesthesia in the lower bicuspids and molar teeth, and in 50 per cent of the cases, the cuspid, (in some cases the lateral incisor) and in addition the alveolar process, as well as a part of the body of the mandible and buccal soft tissues. Therefore, if the cuspid and incisor teeth are to be operated, in addition to the posterior teeth, it is, in most cases, necessary to block the interlacing or overlapping branches from the inferior dental on the opposite side. This is accomplished by making the incisive injection in the incisive fossa, on the opposite side from that of the inferior dental. For example, if the right inferior dental is injected and anesthesia is desired to the median line, then block the overlapping branches by making an incisive injection in the left incisive fossa. (For technic of blocking the incisive nerve, see page 611.) If anesthesia is to include the lateral incisor, then make the incisive injection on the side of the inferior dental injection. Or in case the cuspid tooth is to be operated as, for example, cavity preparation, or pulp removal, block the interlacing branches at the incisive fossa on the same side of injection, in addition to the inferior dental. If the bicuspids, cuspids, lateral and central incisor teeth on the opposite side are to be included, instead of blocking the inferior dental on that side, the mental injection is made. In doing this, anesthesia will not be produced over a large area, it being restricted to the operative area itself, and unnecessary tissue is not anesthetized, which would be the case if the inferior dental nerve was blocked. It must also be remembered that the inferior dental nerve can be thoroughly blocked, and yet the tissues to the distal and buccal of the lower second and third molars be highly sensitive. This is due to these tissues being supplied by the long buccal nerve in 75 per cent of the cases. (See technic for blocking the long buccal nerve, page 581.)

The interlacing branches on the lingual side must be anesthetized as in the case of the inferior dental. The operator should review the anatomy of the lingual nerve and see just what structures are supplied by it, and at what point the right and left lingual nerves overlap in the anterior region of the tongue and floor of the mouth. The blocking of the lingual nerve will in nearly every case produce anesthesia on the lingual side as far anteriorly as the cuspid or lateral. However, if the cuspid tooth is to be removed, it may be necessary to block the overlapping branches from the opposite lingual nerve, by injecting the solution anterior to the cuspid. (For detailed technic, see page 623.) In case the lingual tissues are involved up to the median line, it is necessary to block the overlapping branches from the opposite side by depositing the solution across the median line lingually to the apices of the central and lateral incisor teeth. (For detailed technic, see page 623.)

In case the blocking is for a major oral operation, such as the curettement of considerable bone, the reduction of a fracture, or for plastic surgery, such as will involve the external tissues covering the outer and lower borders of the mandible, in addition to the inferior dento-lingual injection (which in most cases will be contraindicated) the part is blocked by the extraoral, third division method, as given on page 525. In addition, the tissues along the lower outer border of the body and ramus of the mandible are blocked by the circular or regional method. (See Fig. 408.) These injections by the circular method block the communicating branches from the cervical plexus. (For technic, see page 673.)

Contraindications for Blocking the Inferior Dental and Lingual Nerves.—The blocking of the inferior dental and lingual nerve branches is contraindicated if infection is present within the oral cavity to any considerable extent. However, a patient may have an abscessed tooth, and the infection not involve much tissue. If the infection should involve considerable tissue and the mucous membrane is in a state of inflammation on the side of injection, as is the case many times in unerupted or impacted lower third molars, the inferior dental and lingual nerves should not be blocked by the intraoral method. The reader well knows that in many cases of unerupted or impacted lower third molars, there is considerable infection in the gum tissue and mucosa covering the unerupted tooth and alveolar process. If the inflammation is slight, and the area can be thoroughly prepared by spraying and the application of tincture of iodin, there is little or no chance for postoperative complications. Should considerable infection be present, with false ankylosis existing, or in case of a fracture, it will be found difficult to block

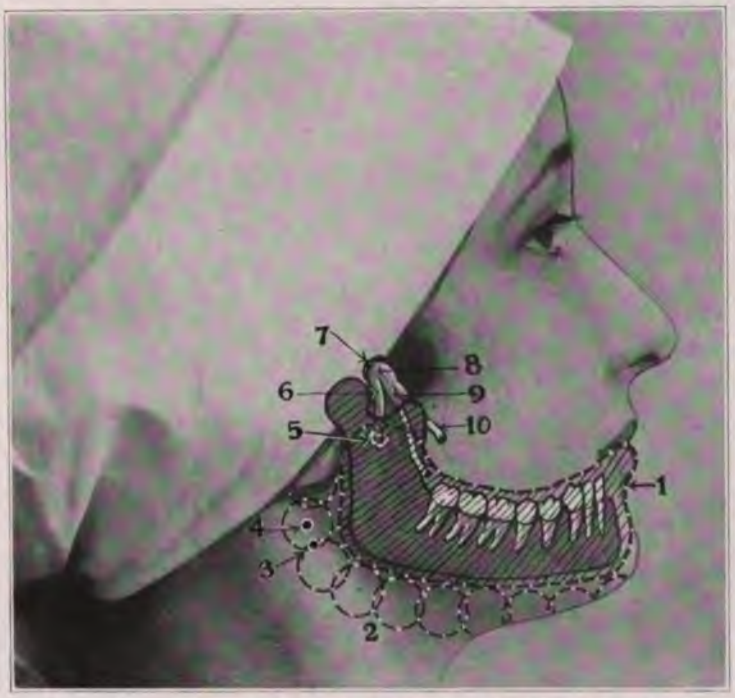

Fig. 408.—Area of anesthesia secured by the inferior dental and circular injections.

1, Dotted line outlining area blocked following inferior dental injection. 2, Each circle represents the injection of one half mil of solution for blocking the overlapping branches from the cervical plexus. This method of injecting is employed in fractures, etc., in addition to blocking the inferior dental-lingual nerves or the third division. 3 and 4, represent initial points of injection; 5 and 6, inferior dental nerve and foramen; 7, foramen ovale; 8, mandibular or third division; 9, lingual nerve; 10, long buccal nerve.

the lingual and inferior dental nerve branches by the intraoral method, and the operator would assume considerable risk in carrying infection into healthy tissues. Therefore, the extraoral method should be employed for blocking the third or mandibular division of the fifth nerve at a point 1 cm. to the antero-inferior of the foramen ovale, as described on page 525, or blocking the inferior dentolingual branches by the extraoral method, by inserting the needle lingually to the ascending ramus and lower border of the mandible, as given on page 560. See Figs. 411 and 412.

The Cause of Prolonged Anesthesia Following the Blocking of the Inferior Dento-Lingual Nerves.—The author has had a number of cases reported to him, by members of the profession, with reference to prolonged anesthesia following the blocking of the inferior dental and lingual nerves. He has made a careful study of the causes and has in almost every case traced the etiology of this condition to the operation, or to the injection of a solution contaminated with alcohol. If the anesthetizing solution conforms to all the physical and physiological laws, no pathological changes will take place in the delicate tissues which receive the solution, and the operator who places the blame upon the nerve block method is doing so unjustly. The reader is referred to Chapter XX for the purpose of familiarizing himself with the anesthetic solutions, the proper constituents, and their therapeutic action; also to Chapter XIX which describes the vehicle. It has been proved that a properly prepared procain, suprarenin, Ringer solution is a nonirritant, and will not cause the slightest pathological change in the delicate tissues injected, provided, of course, the solution has been injected in the proper manner. In a number of troublesome cases reported to the writer, he has learned that the operator performed some operation, such as the extraction of the

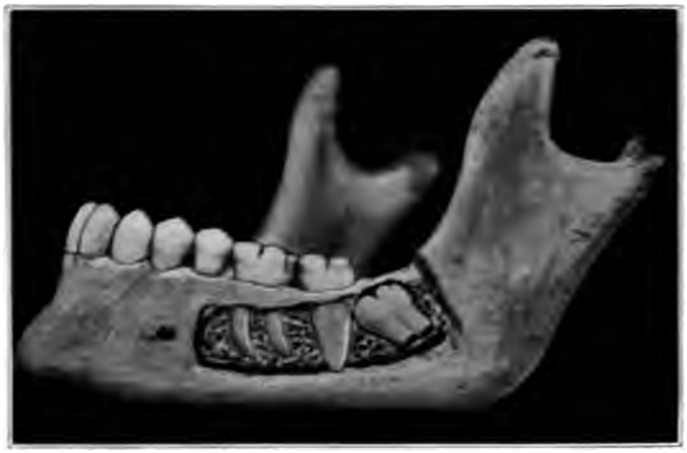

Fig. 409.—The mandible with bone resected to show relation of the inferior dental canal to the apices of roots. The second molar forms a saddle over the canal which is a condition existing in many cases which may cause postoperative pain. If the roots of the third molar were fully formed they would no doubt extend into or even below the inferior dental canal.

lower first or second molar tooth, or the curettement of the alveolar socket. Figs. 110, 409, and 410 illustrate the inferior dental canal and its close relationship to the apices of the lower second and third molar roots. It is self-evident that if these teeth are radiographed, and an area of necrosis is found around the apices of the roots, then the teeth extracted, and the sockets improperly curetted, injury of the inferior dental nerve is very likely to occur. Teeth in such a pathological condition should be removed surgically, the operator following a definite technic for their removal. If a differentiation is made between pathological and healthy tissue, he will avoid trauma to, or severance of the nerve, thereby prolonging anesthesia. The curettement of the alveolar socket following the extraction of the lower bicuspid and molar teeth has, in a number of cases, resulted in injury to the inferior dental nerve. A small, sharp curette, inserted into an alveolar socket will readily penetrate, not only the area of necrosed bone, as shown by the dental radiograph, but the HEALTHY middle alveolar plate, is easily penetrated. The inferior dental nerve may be located very close to the apices of the roots of the teeth, and slight pressure on the curette may produce trauma or laceration of the epineurium, or the curette may actually sever some of the fibers which comprise the inferior dental nerve. The location and extent of prolonged postoperative anesthesia depend on the number of nerve fibers destroyed. If only a few nerve fibers have been severed, then the anesthesia will be very slight, whereas, if a number of them have been involved, the anesthesia will extend over a greater area. The skin and mucous membrane anesthetized may vary from 1 cm. to 2 or 3 cm. in diameter. The anesthesia

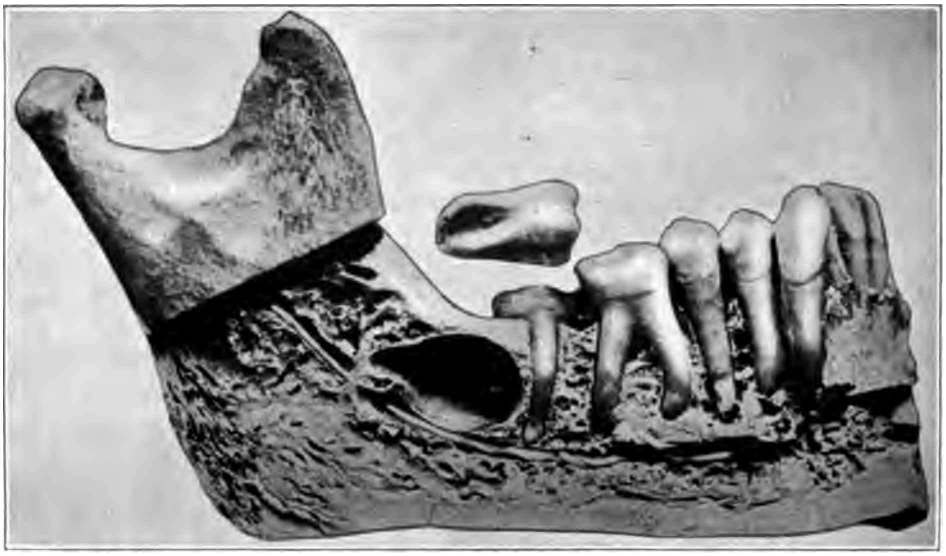

Fig. 410. An impacted lower third molar showing its relation to the inferior dental nerve. Illustration shows the tooth removed from its socket. Note the close relation of the tooth to the inferior dental nerve which is a common cause of neuralgia due to pressure. (After Cryer.)

may be so slight that it is not noticeable to the individual, only when the finger is placed on the part and comparison of the partially anesthetized area with the surrounding normal tissue is made. Several cases have been observed in which a small area of anesthesia was present which was readily noticed by the patient while passing the razor over his face while shaving. Some patients have returned to their dentists and complained of this numbness, and the writer regrets to say that in the majority of cases the dentist has blamed the method of block anesthesia, when it had nothing to do with producing the condition. If nitrous oxid-oxygen or ether had been administered and the same operative procedure had been employed, the same condition would have been brought about. Prolonged anesthesia of a part has followed operations under general anesthesia the same as under block anesthesia.

If the apices of the lower molars are in contact with the inferior dental nerve, and these teeth are difficult to extract; many times when the tooth leaves the socket, it will slightly injure the inferior dental nerve, resulting in numbness of the tissue at a distant point. A friend of the writer, a dentist, has had an interesting case, the narration of which will be of value to the exodontist. About one year ago this operator blocked the inferior dental and lingual nerves for the removal of an impacted lower third molar which was lingually inclined and of the third degree type. During the process of removal a portion of the linguo-alveolar plate was removed and the lingual beak of the forceps accidentally placed too low on the lingual side, which resulted in injuring the lingual nerve. The reader will remember that in the description of the lingual nerve, it was said that in some cases it was located very close to, or even in contact with, the periosteum covering the linguoalveolar plate of the lower third molar when the tooth was in the normal position; notwithstanding the fact that if the lower third molar is lingually inclined, it causes a protrusion of the alveolar process covering the lingual portion, and the lingual nerve would be in contact with this part. If extreme caution is not taken during the surgical removal of this tooth, the lingual nerve may be injured. (See Figs. 99 and 100.) In the case just mentioned, the patient returned to the operator about two weeks after the extraction, and complained of profound anesthesia of the anterior two-thirds of the tongue and soft tissues in the floor of the mouth. The writer was called in consultation, and on examination of the patient found that the lingual nerve had been severed during the removal of the impacted third molar. The operator who removed the tooth, attributed the cause of prolonged anesthesia to the block method, when the anesthetic had nothing to do with it. This condition no doubt would have happened had nitrous oxid-oxygen or ether been administered.

In case a lower third molar, which is impacted and lingually inclined, is to be removed, extreme caution must be exercised during the surgical procedure to avoid injury of the lingual nerve. If the dental radiogram reveals considerable absorption around the apices of the lower teeth, care should be observed while curetting, following the extracting. A well-defined radiogram will reveal the location of the inferior dental canal, and it is an excellent guide for the operator to use in dealing with these cases. Even in some instances in which no infection is present, or no curetting done, the apices of the lower molars may be in close contact with the inferior dental nerve, and during the process of a difficult extraction, trauma or laceration of the inferior dental nerve may take place, which will result in slight numbness or anesthesia of the tissues supplied by the severed nerve fibers. In all cases that have been reported to the writer, not a single case has involved the upper jaw, but all cases have been restricted to the region of the inferior dental nerve. The reason for this is that the curetting of a superior alveolar socket is different from the curetting of a lower socket, because the branches of the outer nerve loop which supply the upper molars and bicuspid teeth are arranged differently as compared to the nerves supplying the teeth in the lower jaw. The severing of the branches of the outer nerve loop, which enter the respective apices of the upper molars and bicuspid teeth, will not cause prolonged postoperative anesthesia, because they are not supplied by a nerve branch, such as the inferior dental. The nerve fibers comprising the inferior dental nerve pass anteriorly to the point which has been curetted, or the tooth extracted, to supply the tissue anteriorly, and if the nerve branches are mutilated, naturally, anesthesia of the part which they supply is produced. Again repeating, the operator should be very careful in using a small sharp curette, especially in the sockets of the lower molars, following extraction. In these cases it is advisable to take dental radiograms and correctly interpret them before operating and if necessary make a second radiograph to check up the case.

In those cases in which the inferior dental nerve fibers have been injured, and an area of numbness has been produced in the tissues, usually the normal sensation will return in from one to six months, this depending upon the amount of destruction, as the nerve fibers destroyed must regenerate and the regeneration is very slow. (See page 54.) Nothing serious can result, other than the inconvenience caused to the patient by an area of numbness of a circumscribed area of the tissues. Practically nothing can be done so far as treatment is concerned. However, massage and electricity are of value although the numbness or anesthesia will gradually subside if nothing at all is done. The operator or patient should not become alarmed, as nature will slowly heal the nerve fibers which have been injured, and sensation will return.

BLOCKING THE INFERIOR DENTAL AND LINGUAL NERVES IN CHILDREN

If the inferior dental and lingual nerves are being blocked for a child, the needle is inserted at a point approximately seven millimeters above the occlusal plane of the lower teeth, instead of the level of 1 cm. which is employed in the adult. The average depth for inserting the needle to block the inferior dental nerve for an adult is approximately 2 cm., but with the child the average depth is fifteen millimeters. Instead of the lingual nerve being located 1 cm. from the surface of the mucous membrane, it is situated at an average depth of 6 mm. These nerve branches are blocked in identically the same manner as the technic for the adult, with the exception that the needle is slightly elevated as advanced into the tissues and is inserted at a point lower than 1 cm. above the occlusal plane of the lower teeth. (See Fig. 402.)

The author has stated many times that if block anesthesia is employed only for the treatment of the broken down lower first permanent molar, or for the extraction of these teeth, the operator is well repaid for the time consumed in entering the great field of block anesthesia. We are all aware that many times the neglected lower first molar must be extracted and the blocking of the inferior dento-lingual nerve branches makes the removal of these teeth absolutely painless. An operation performed in this manner creates a profoundly favorable impression upon the little patient that the teeth can be operated without his suffering intense pain. Last, but not least, the child is not afraid to return to the dentist who renders this class of service. There is a striking contrast between the services rendered by the dentist who employs methods of eliminating all pain in comparison with the one who inflicts excruciating pain upon the child and leaves in his mind a horror of the dental chair and for future dental treatment. The inferior dento-lingual injection is not contraindicated in a child, and should be employed, whenever necessary. For the extraction of deciduous teeth, subperiosteal, terminal or infiltration anesthesia will, in most cases, produce profound anesthesia, so that the teeth can be painlessly removed. However, if the tooth or teeth are abscessed, it is better to make the inferior dento-lingual block injection than it is to insert the needle into inflamed or infected tissue. This deep block injection is of great value in the blocking of the first permanent molar in the young child, as well as for operations which involve other permanent teeth. The inferior dento-lingual nerves can be blocked with little or no appreciable pain to the child; in fact, much easier and with less resistance on the part of the patient than if the subperiosteal, terminal or infiltration method is employed.

BLOCKING THE INFERIOR DENTAL AND LINGUAL NERVES BY THE EXTRAORAL ROUTE

Thoma has advocated the blocking of these nerves by the extraoral route, which is accomplished by inserting the needle in the skin at the lingual side of the angle of the mandible. See Figs. 411 and 412. The skin at the angle of the jaw is thoroughly prepared by the application of tincture of iodin. Needle No. 8 is employed, which is 20 gauge, and 60 mm. long. (See Fig. 177.) The preliminary injection is made into the skin, using needle No. 7, injecting at least one mil of the solution. After waiting five minutes for the solution to anesthetize the skin and subcutaneous tissue, the regular nerve blocking needle is advanced through the tissue just lingual and anterior to the angle of the ramus. (See Fig. 412.) The needle is advanced upward and slightly laterally in the soft tissue, and when the needle is at an approximate depth of 2 cm. the periosteum covering the lingual portion of the ascending ramus is reached, after which the periosteum is followed until approximately 4 cm. of the needle has been advanced into the tissue, leaving 1 cm. to remain on the exterior. The needle should be advanced into the tissue, directing it to a point 5 mm. anterior to the inferior dental nerve as it enters the inferior dental foramen. If this is done, the solution will be deposited 5 mm. anterior to the inferior dental nerve, and 5 mm. posterior and lateral to the lingual nerve, and the solution will readily reach both nerve branches by infiltration. The amount of solution injected is three mils. Anesthesia is secured in the tissues supplied by these nerves as given under the intraoral method.

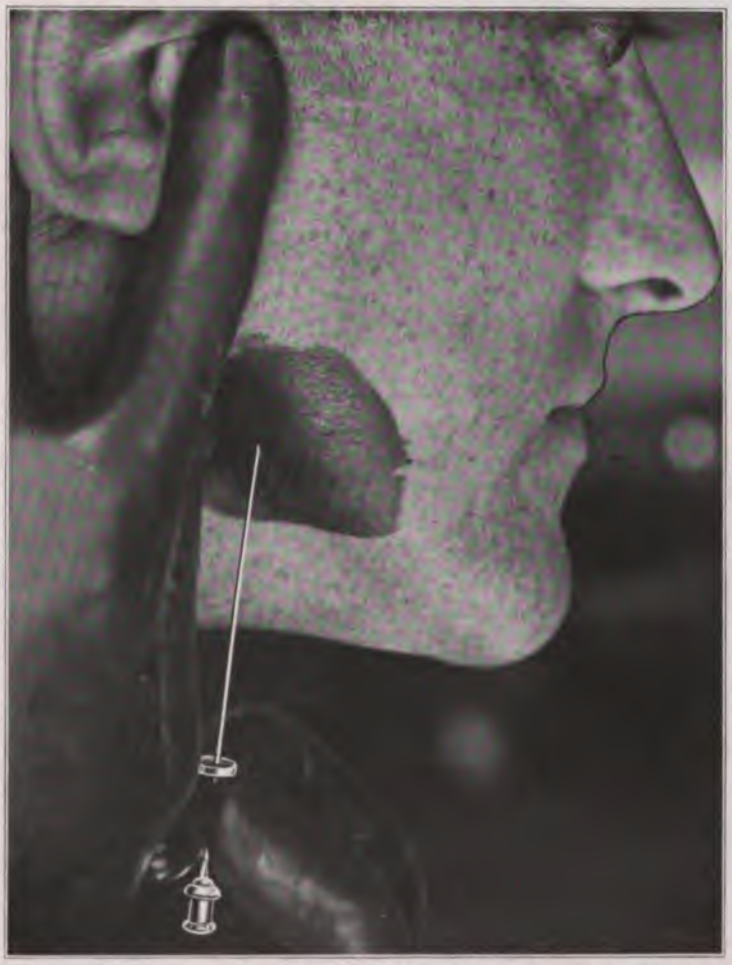

Fig. 411.—Illustrating the position of needle for blocking the inferior dental-lingual nerves by the extraoral method. (Courtesy of Dr. Thoma.)

BLOCKING THE LONG BUCCAL OR BUCCINATOR NERVE

Topography of Anatomy.—The reader is referred to Chapter VII for a complete description of this nerve, hence only a brief consideration will be given here.

This nerve is a branch of the third or mandibular division of the fifth nerve, and arises above the inferior dental and lingual branches. (See Figs.

lingual tissue. It must be remembered that the lingual nerve has nothing to do with the nerve supply of the teeth, labial or buccal structures, and when these tissues are to be operated upon, it is useless to block the lingual nerve.

Structures Anesthetized.—When the inferior dental and lingual nerves are blocked, anesthesia of a very large area is secured. (See below.)

The Inferior Dental Nerve Block; Anesthesia Secured.—The blocking of the inferior dental nerve produces anesthesia of the lower first and second bicuspids, first, second and third lower molars, and in 50 per cent of the cases, the cuspid and partial anesthesia of the lateral incisor. In addition, the alveolar process, buccal periosteum, gum tissue, mucous membrane on the buccal side as far anteriorly as the cuspid, are anesthetized. In some cases anesthesia may extend as near the median line as the labial surface of the lower lateral incisor, and in some instances anesthesia of the tooth may be secured. In addition to the alveolar process, the greater portion of the body of the mandible on the side of injection is blocked. (See Fig. 408.) The extent of anesthesia secured in the lower cuspid, lateral and central incisor teeth, or the tis-

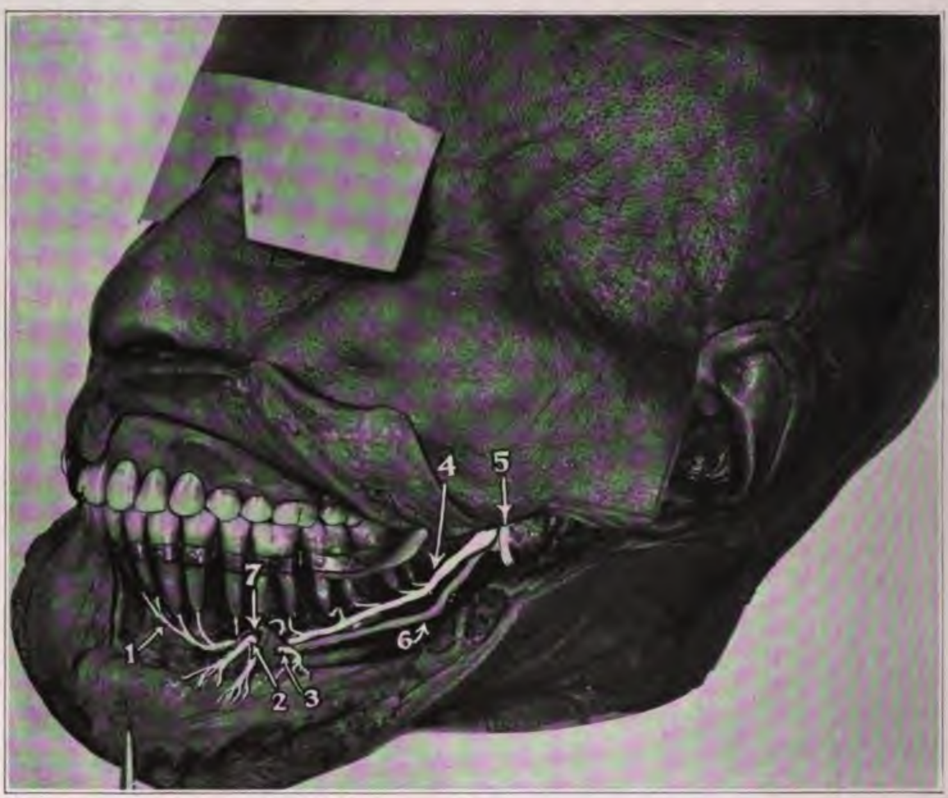

Fig. 406.—Dissected wet anatomical specimen showing the following structures:
1, Incisive nerves; 2, 3, mental nerves; 4, inferior dental nerves; 5, inferior dental vein (cut); 6, inferior dental artery; 7, mental foramen.

sues near the median line, depends on the interlacing or overlapping nerve branches from the opposite side. In many instances the four lower and in some cases the six anterior teeth, alveolar process and labial structures are supplied by branches from both the right and left inferior dental nerves. Therefore, with a rich nerve supply from two different sources, it is impossible to prepare hypersensitive gingival cavities in the cuspid, lateral or central incisors, or remove the dental pulp without making an additional injection to block the nerve branches which cross the median line from the opposite side. In addition to blocking the inferior dental nerve, it is necessary, in at least 75 per cent of cases, to block the long buccal nerve supplying the gum tissue, mucosa, and periosteum buccal and distal of the lower second and third molars, in addition to the inferior dental for surgical procedures involving the second and third molars, alveolar process and buccal tissues.

The Lingual Nerve Block; Anesthesia Secured.—The blocking of the lingual nerve produces anesthesia in the mucosa and connective tissue in the floor of the mouth, the gum tissue and periosteum situated to the lingual of the lower molars, bicuspids and cuspid, and in some cases the region of the lateral incisor, together with the anterior two-thirds of the tongue. (See Figs. 60 and 99.) It is unnecessary to block the lingual nerve for operative dentistry, but if the teeth are to be extracted or the lingual tissues are involved in the operation, then it is essential to block the lingual, either in conjunction with or without the inferior dental blocking, this depending on the nature of the operation.

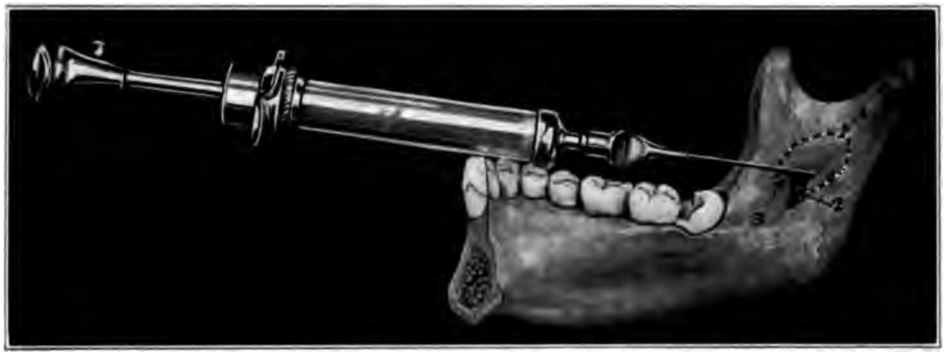

Fig. 407.—1, Mandibular sulcus; 2, inferior dental foramen and 3, lingula. Dotted outline shows area of diffusion of solution in region of inferior dental nerve.

Blocking the Interlacing or Overlapping Branches.—The blocking of the interlacing or overlapping branches is highly important following the inferior dentolingual injection, and if the nervous anatomy is understood by the operator, he will experience little difficulty in producing profound anesthesia of any part supplied by the inferior dental and lingual nerves. It has been stated under "Structures Anesthetized," that the blocking of the inferior dental nerve produces anesthesia in the lower bicuspids and molar teeth, and in 50 per cent of the cases, the cuspid, (in some cases the lateral incisor) and in addition the alveolar process, as well as a part of the body of the mandible and buccal soft tissues. Therefore, if the cuspid and incisor teeth are to be operated, in addition to the posterior teeth, it is, in most cases, necessary to block the interlacing or overlapping branches from the inferior dental on the opposite side. This is accomplished by making the incisive injection in the incisive fossa, on the opposite side from that of the inferior dental. For example, if the right inferior dental is injected and anesthesia is desired to the median line, then block the overlapping branches by making an incisive injection in the left incisive fossa. (For technic of blocking the incisive nerve, see page 611.) If anesthesia is to include the lateral incisor, then make the incisive injection on the side of the inferior dental injection. Or in case the cuspid tooth is to be operated as, for example, cavity preparation, or pulp removal, block the interlacing branches at the incisive fossa on the same side of injection, in addition to the inferior dental. If the bicuspids, cuspids, lateral and central incisor teeth on the opposite side are to be included, instead of blocking the inferior dental on that side, the mental injection is made. In doing this, anesthesia will not be produced over a large area, it being restricted to the operative area itself, and unnecessary tissue is not anesthetized, which would be the case if the inferior dental nerve was blocked. It must also be remembered that the inferior dental nerve can be thoroughly blocked, and yet the tissues to the distal and buccal of the lower second and third molars be highly sensitive. This is due to these tissues being supplied by the long buccal nerve in 75 per cent of the cases. (See technic for blocking the long buccal nerve, page 581.)

The interlacing branches on the lingual side must be anesthetized as in the case of the inferior dental. The operator should review the anatomy of the lingual nerve and see just what structures are supplied by it, and at what point the right and left lingual nerves overlap in the anterior region of the tongue and floor of the mouth. The blocking of the lingual nerve will in nearly every case produce anesthesia on the lingual side as far anteriorly as the cuspid or lateral. However, if the cuspid tooth is to be removed, it may be necessary to block the overlapping branches from the opposite lingual nerve, by injecting the solution anterior to the cuspid. (For detailed technic, see page 623.) In case the lingual tissues are involved up to the median line, it is necessary to block the overlapping branches from the opposite side by depositing the solution across the median line lingually to the apices of the central and lateral incisor teeth. (For detailed technic, see page 623.)

In case the blocking is for a major oral operation, such as the curettement of considerable bone, the reduction of a fracture, or for plastic surgery, such as will involve the external tissues covering the outer and lower borders of the mandible, in addition to the inferior dento-lingual injection (which in most cases will be contraindicated) the part is blocked by the extraoral, third division method, as given on page 525. In addition, the tissues along the lower outer border of the body and ramus of the mandible are blocked by the circular or regional method. (See Fig. 408.) These injections by the circular method block the communicating branches from the cervical plexus. (For technic, see page 673.)

Contraindications for Blocking the Inferior Dental and Lingual Nerves.—The blocking of the inferior dental and lingual nerve branches is contraindicated if infection is present within the oral cavity to any considerable extent. However, a patient may have an abscessed tooth, and the infection not involve much tissue. If the infection should involve considerable tissue and the mucous membrane is in a state of inflammation on the side of injection, as is the case many times in unerupted or impacted lower third molars, the inferior dental and lingual nerves should not be blocked by the intraoral method. The reader well knows that in many cases of unerupted or impacted lower third molars, there is considerable infection in the gum tissue and mucosa covering the unerupted tooth and alveolar process. If the inflammation is slight, and the area can be thoroughly prepared by spraying and the application of tincture of iodin, there is little or no chance for postoperative complications. Should considerable infection be present, with false ankylosis existing, or in case of a fracture, it will be found difficult to block

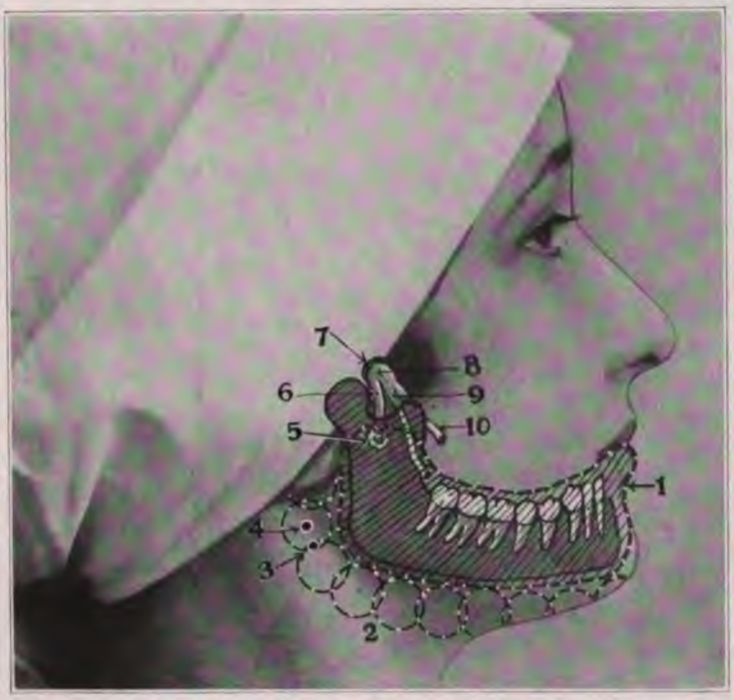

Fig. 408.—Area of anesthesia secured by the inferior dental and circular injections.

1, Dotted line outlining area blocked following inferior dental injection. 2, Each circle represents the injection of one half mil of solution for blocking the overlapping branches from the cervical plexus. This method of injecting is employed in fractures, etc., in addition to blocking the inferior dental-lingual nerves or the third division. 3 and 4, represent initial points of injection; 5 and 6, inferior dental nerve and foramen; 7, foramen ovale; 8, mandibular or third division; 9, lingual nerve; 10, long buccal nerve.

the lingual and inferior dental nerve branches by the intraoral method, and the operator would assume considerable risk in carrying infection into healthy tissues. Therefore, the extraoral method should be employed for blocking the third or mandibular division of the fifth nerve at a point 1 cm. to the antero-inferior of the foramen ovale, as described on page 525, or blocking the inferior dentolingual branches by the extraoral method, by inserting the needle lingually to the ascending ramus and lower border of the mandible, as given on page 580. (See Figs. 411 and 412.)

The Cause of Prolonged Anesthesia Following the Blocking of the Inferior Dento-Lingual Nerves.—The author has had a number of cases reported to him, by members of the profession, with reference to prolonged anesthesia following the blocking of the inferior dental and lingual nerves. He has made a careful study of the causes and has in almost every case traced the etiology of this condition to the operation, or to the injection of a solution contaminated with alcohol. If the anesthetizing solution conforms to all the physical and physiological laws, no pathological changes will take place in the delicate tissues which receive the solution, and the operator who places the blame upon the nerve block method is doing so unjustly. The reader is referred to Chapter XX for the purpose of familiarizing himself with the anesthetic solutions, the proper constituents, and their therapeutic action; also to Chapter XIX which describes the vehicle. It has been proved that a properly prepared procain, suprarenin, Ringer solution is a nonirritant, and will not cause the slightest pathological change in the delicate tissues injected, provided, of course, the solution has been injected in the proper manner. In a number of troublesome cases reported to the writer, he has learned that the operator performed some operation, such as the extraction of the

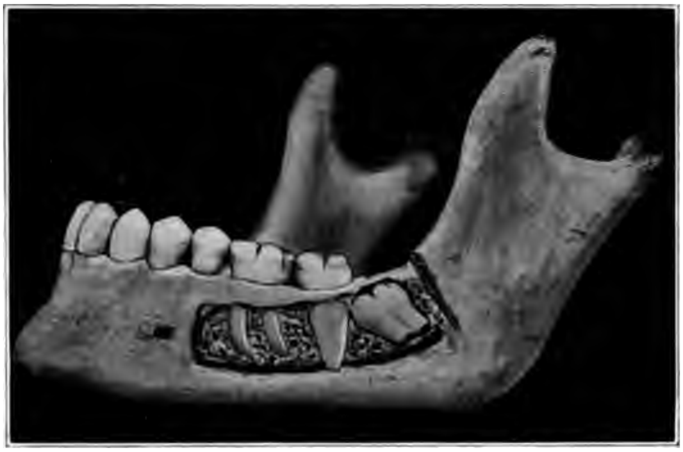

Fig. 409.—The mandible with bone resected to show relation of the inferior dental canal to the apices of roots. The second molar forms a saddle over the canal which is a condition existing in many cases which may cause postoperative pain. If the roots of the third molar were fully formed they would no doubt extend into or even below the inferior dental canal.

lower first or second molar tooth, or the curettement of the alveolar socket. Figs. 110, 409, and 410 illustrate the inferior dental canal and its close relationship to the apices of the lower second and third molar roots. It is self-evident that if these teeth are radiographed, and an area of necrosis is found around the apices of the roots, then the teeth extracted, and the sockets improperly curetted, injury of the inferior dental nerve is very likely to occur. Teeth in such a pathological condition should be removed surgically, the operator following a definite technic for their removal. If a differentiation is made between pathological and healthy tissue, he will avoid trauma to, or severance of the nerve, thereby prolonging anesthesia. The curettement of the alveolar socket following the extraction of the lower bicuspid and molar teeth has, in a number of cases, resulted in injury to the inferior dental nerve. A small, sharp curette, inserted into an alveolar socket will readily penetrate, not only the area of necrosed bone, as shown by the dental radiograph, but the HEALTHY middle alveolar plate, is easily penetrated. The inferior dental nerve may be located very close to the apices of the roots of the teeth, and slight pressure on the curette may produce trauma or laceration of the epineurium, or the curette may actually sever some of the fibers which comprise the inferior dental nerve. The location and extent of prolonged postoperative anesthesia depend on the number of nerve fibers destroyed. If only a few nerve fibers have been severed, then the anesthesia will be very slight, whereas, if a number of them have been involved, the anesthesia will extend over a greater area. The skin and mucous membrane anesthetized may vary from 1 cm. to 2 or 3 cm. in diameter. The anesthesia

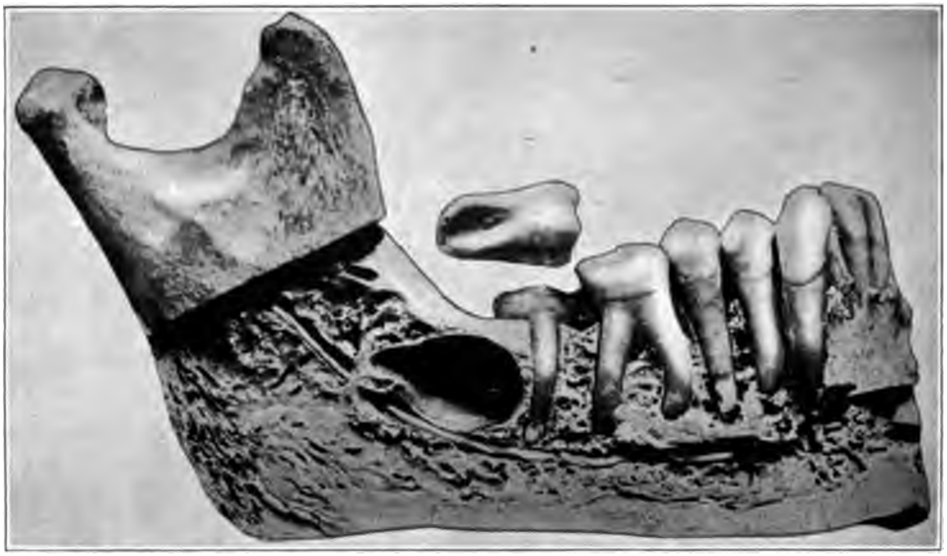

Fig. 410. An impacted lower third molar showing its relation to the inferior dental nerve. Illustration shows the tooth removed from its socket. Note the close relation of the tooth to the inferior dental nerve which is a common cause of neuralgia due to pressure. (After Cryer.)

may be so slight that it is not noticeable to the individual, only when the finger is placed on the part and comparison of the partially anesthetized area with the surrounding normal tissue is made. Several cases have been observed in which a small area of anesthesia was present which was readily noticed by the patient while passing the razor over his face while shaving. Some patients have returned to their dentists and complained of this numbness, and the writer regrets to say that in the majority of cases the dentist has blamed the method of block anesthesia, when it had nothing to do with producing the condition. If nitrous oxid-oxygen or ether had been administered and the same operative procedure had been employed, the same condition would have been brought about. Prolonged anesthesia of a part has followed operations under general anesthesia the same as under block anesthesia.

If the apices of the lower molars are in contact with the inferior dental nerve, and these teeth are difficult to extract; many times when the tooth leaves the socket, it will slightly injure the inferior dental nerve, resulting in numbness of the tissue at a distant point. A friend of the writer, a dentist, has had an interesting case, the narration of which will be of value to the exodontist. About one year ago this operator blocked the inferior dental and lingual nerves for the removal of an impacted lower third molar which was lingually inclined and of the third degree type. During the process of removal a portion of the linguo-alveolar plate was removed and the lingual beak of the forceps accidentally placed too low on the lingual side, which resulted in injuring the lingual nerve. The reader will remember that in the description of the lingual nerve, it was said that in some cases it was located very close to, or even in contact with, the periosteum covering the linguoalveolar plate of the lower third molar when the tooth was in the normal position; notwithstanding the fact that if the lower third molar is lingually inclined, it causes a protrusion of the alveolar process covering the lingual portion, and the lingual nerve would be in contact with this part. If extreme caution is not taken during the surgical removal of this tooth, the lingual nerve may be injured. (See Figs. 99 and 100.) In the case just mentioned, the patient returned to the operator about two weeks after the extraction, and complained of profound anesthesia of the anterior two-thirds of the tongue and soft tissues in the floor of the mouth. The writer was called in consultation, and on examination of the patient found that the lingual nerve had been severed during the removal of the impacted third molar. The operator who removed the tooth, attributed the cause of prolonged anesthesia to the block method, when the anesthetic had nothing to do with it. This condition no doubt would have happened had nitrous oxid-oxygen or ether been administered.

In case a lower third molar, which is impacted and lingually inclined, is to be removed, extreme caution must be exercised during the surgical procedure to avoid injury of the lingual nerve. If the dental radiogram reveals considerable absorption around the apices of the lower teeth, care should be observed while curetting, following the extracting. A well-defined radiogram will reveal the location of the inferior dental canal, and it is an excellent guide for the operator to use in dealing with these cases. Even in some instances in which no infection is present, or no curetting done, the apices of the lower molars may be in close contact with the inferior dental nerve, and during the process of a difficult extraction, trauma or laceration of the inferior dental nerve may take place, which will result in slight numbness or anesthesia of the tissues supplied by the severed nerve fibers. In all cases that have been reported to the writer, not a single case has involved the upper jaw, but all cases have been restricted to the region of the inferior dental nerve. The reason for this is that the curetting of a superior alveolar socket is different from the curetting of a lower socket, because the branches of the outer nerve loop which supply the upper molars and bicuspid teeth are arranged differently as compared to the nerves supplying the teeth in the lower jaw. The severing of the branches of the outer nerve loop, which enter the respective apices of the upper molars and bicuspid teeth, will not cause prolonged postoperative anesthesia, because they are not supplied by a nerve branch, such as the inferior dental. The nerve fibers comprising the inferior dental nerve pass anteriorly to the point which has been curetted, or the tooth extracted, to supply the tissue anteriorly, and if the nerve branches are mutilated, naturally, anesthesia of the part which they supply is produced. Again repeating, the operator should be very careful in using a small sharp curette, especially in the sockets of the lower molars, following extraction. In these cases it is advisable to take dental radiograms and correctly interpret them before operating and if necessary make a second radiograph to check up the case.

In those cases in which the inferior dental nerve fibers have been injured, and an area of numbness has been produced in the tissues, usually the normal sensation will return in from one to six months, this depending upon the amount of destruction, as the nerve fibers destroyed must regenerate and the regeneration is very slow. (See page 54.) Nothing serious can result, other than the inconvenience caused to the patient by an area of numbness of a circumscribed area of the tissues. Practically nothing can be done so far as treatment is concerned. However, massage and electricity are of value although the numbness or anesthesia will gradually subside if nothing at all is done. The operator or patient should not become alarmed, as nature will slowly heal the nerve fibers which have been injured, and sensation will return.

BLOCKING THE INFERIOR DENTAL AND LINGUAL NERVES IN CHILDREN

If the inferior dental and lingual nerves are being blocked for a child, the needle is inserted at a point approximately seven millimeters above the occlusal plane of the lower teeth, instead of the level of 1 cm. which is employed in the adult. The average depth for inserting the needle to block the inferior dental nerve for an adult is approximately 2 cm., but with the child the average depth is fifteen millimeters. Instead of the lingual nerve being located 1 cm. from the surface of the mucous membrane, it is situated at an average depth of 6 mm. These nerve branches are blocked in identically the same manner as the technic for the adult, with the exception that the needle is slightly elevated as advanced into the tissues and is inserted at a point lower than 1 cm. above the occlusal plane of the lower teeth. (See Fig. 402.)

The author has stated many times that if block anesthesia is employed only for the treatment of the broken down lower first permanent molar, or for the extraction of these teeth, the operator is well repaid for the time consumed in entering the great field of block anesthesia. We are all aware that many times the neglected lower first molar must be extracted and the blocking of the inferior dento-lingual nerve branches makes the removal of these teeth absolutely painless. An operation performed in this manner creates a profoundly favorable impression upon the little patient that the teeth can be operated without his suffering intense pain. Last, but not least, the child is not afraid to return to the dentist who renders this class of service. There is a striking contrast between the services rendered by the dentist who employs methods of eliminating all pain in comparison with the one who inflicts excruciating pain upon the child and leaves in his mind a horror of the dental chair and for future dental treatment. The inferior dento-lingual injection is not contraindicated in a child, and should be employed, whenever necessary. For the extraction of deciduous teeth, subperiosteal, terminal or infiltration anesthesia will, in most cases, produce profound anesthesia, so that the teeth can be painlessly removed. However, if the tooth or teeth are abscessed, it is better to make the inferior dento-lingual block injection than it is to insert the needle into inflamed or infected tissue. This deep block injection is of great value in the blocking of the first permanent molar in the young child, as well as for operations which involve other permanent teeth. The inferior dento-lingual nerves can be blocked with little or no appreciable pain to the child; in fact, much easier and with less resistance on the part of the patient than if the subperiosteal, terminal or infiltration method is employed.

BLOCKING THE INFERIOR DENTAL AND LINGUAL NERVES BY THE EXTRAORAL ROUTE

Thoma has advocated the blocking of these nerves by the extraoral route, which is accomplished by inserting the needle in the skin at the lingual side of the angle of the mandible. See Figs. 411 and 412. The skin at the angle of the jaw is thoroughly prepared by the application of tincture of iodin. Needle No. 8 is employed, which is 20 gauge, and 60 mm. long. (See Fig. 177.) The preliminary injection is made into the skin, using needle No. 7, injecting at least one mil of the solution. After waiting five minutes for the solution to anesthetize the skin and subcutaneous tissue, the regular nerve blocking needle is advanced through the tissue just lingual and anterior to the angle of the ramus. (See Fig. 412.) The needle is advanced upward and slightly laterally in the soft tissue, and when the needle is at an approximate depth of 2 cm. the periosteum covering the lingual portion of the ascending ramus is reached, after which the periosteum is followed until approximately 4 cm. of the needle has been advanced into the tissue, leaving 1 cm. to remain on the exterior. The needle should be advanced into the tissue, directing it to a point 5 mm. anterior to the inferior dental nerve as it enters the inferior dental foramen. If this is done, the solution will be deposited 5 mm. anterior to the inferior dental nerve, and 5 mm. posterior and lateral to the lingual nerve, and the solution will readily reach both nerve branches by infiltration. The amount of solution injected is three mils. Anesthesia is secured in the tissues supplied by these nerves as given under the intraoral method.

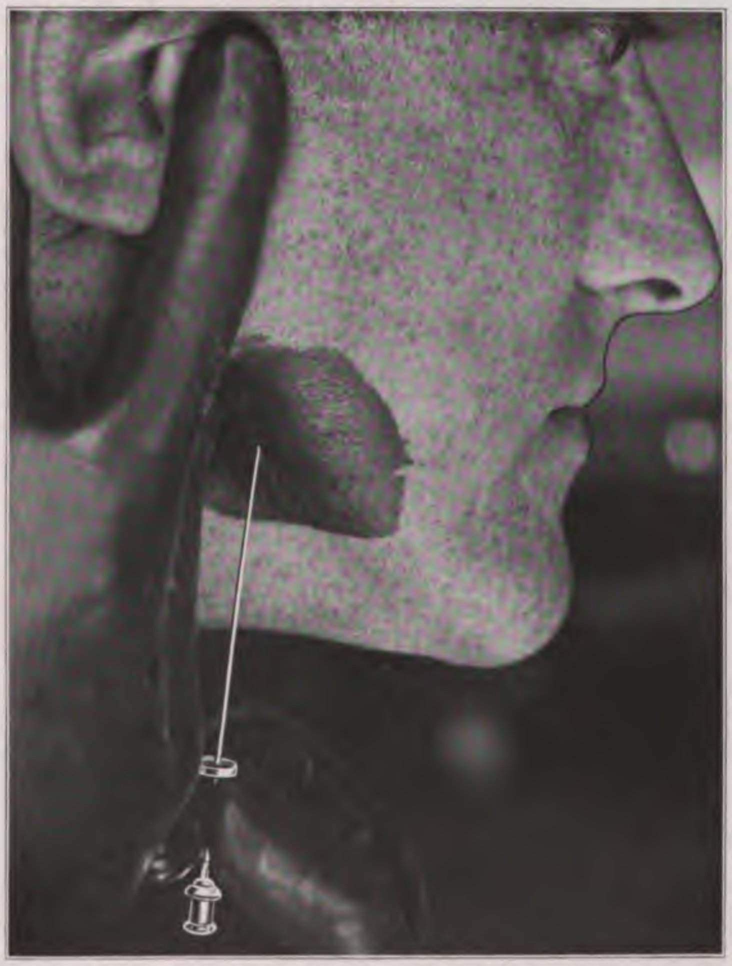

Fig. 411.—Illustrating the position of needle for blocking the inferior dental-lingual nerves by the extraoral method. (Courtesy of Dr. Thoma.)

BLOCKING THE LONG BUCCAL OR BUCCINATOR NERVE

Topography of Anatomy.—The reader is referred to Chapter VII for a complete description of this nerve, hence only a brief consideration will be given here.

This nerve is a branch of the third or mandibular division of the fifth nerve, and arises above the inferior dental and lingual branches. (See Figs.

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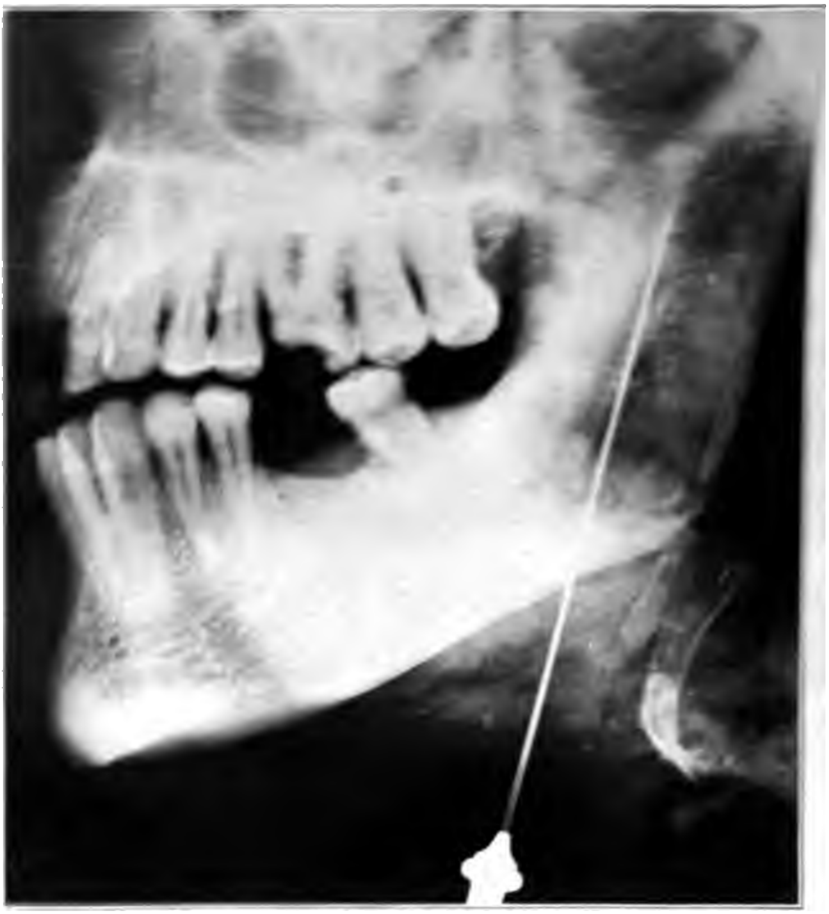

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[illegible] and [illegible]. The first division or ramus continues in a forward direction supplying the integument of the upper part of the buccinator muscle. The lower branch or ramus passes downward and forward in the mucosa and connective tissue until it reaches the angle of the mouth (See Fig. 56.) This branch supplies the mucosa of the cheek, the integument of the buccinator muscle and buccal periosteum and gum tissue covering the bucco-alveolar plate in the region of the second and third lower molars in 75 per cent of cases. In many cases the mucosa located distal to the lower third molar is supplied by this nerve. As near as can be estimated, this nerve supplies the buccal gum tissue and periosteum covering the lower first molar in approximately 5 per cent of the cases. The author has never observed a case in which the buccal tissues in the region of the first and second lower bicuspid teeth were supplied by this nerve branch. It has been his experience to find that in at least 75 per cent of the cases it is necessary to block the long buccal nerve for extraction of the lower second and third molars or for other operations which involve the buccal tissues. Therefore, in approximately 75 per cent of the cases the buccal tissue in the region of the lower second and third molars and distal to the lower third molar, receives its nerve supply from two different sources, namely, from the inferior dental and long buccal nerve branches. When the long buccal nerve supplies this region, it is necessary to block it in addition to the inferior dental. The long buccal nerve differs somewhat in different individuals. This is the reason it is not necessary to block it in approximately 25 per cent of cases, as in these cases, the blocking of the inferior dental nerve produces complete anesthesia of the buccal structures.

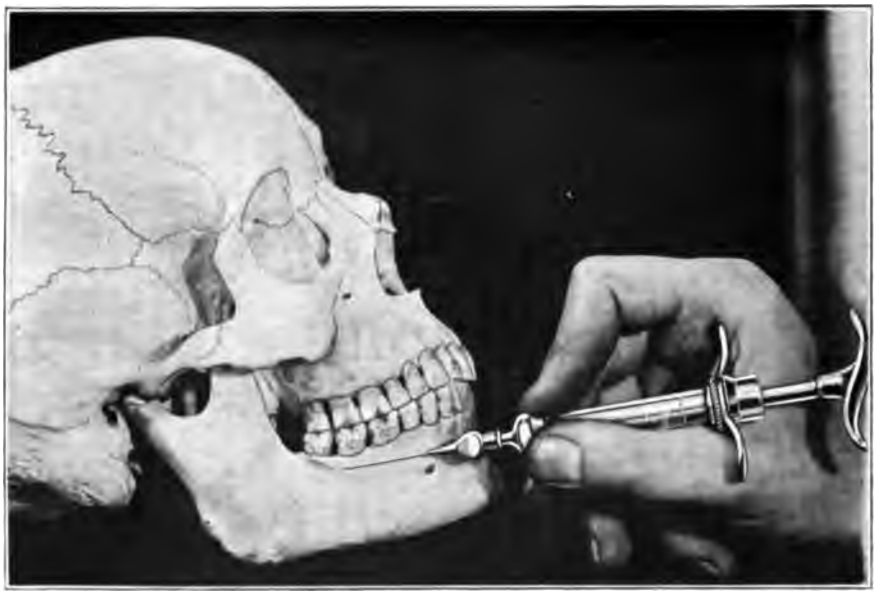


Fig. 413.—First position of needle point for long buccal injection.

Needle Employed.—Needle No. 4, 25 gauge, and 30 mm. in length, is used for this injection.

Technic of Injection.—One of two locations may be employed for blocking the long buccal nerve which are; first, injecting the solution into the tissues buccal and distal to the lower second and third molars. Second; injecting the solution below and posterior to the opening of Stenson's duct.

Technic for Injecting Solution Buccal to the Lower Second and Third Molars for Blocking the Branches of the Long Buccal Nerve.—The mucous membrane, gum tissue, and periosteum located buccally to the lower second and third molars is carefully dried, and a germicidal solution applied. The mucosa is punctured to the buccal of the apex of the distal root of the lower second molar. The needle enters the mucosa at the lowest point, i. e., midway between the cheek and gum tissue in the region of the lower second molar. The syringe is held in the same position as a pen while writing. (See Figs. 413, 414, and 415.) When starting the needle, the patient's mouth should be open so that the area of insertion is fully exposed. (See Fig. 415.) The needle is started into the mucosa, and four minims of the solution are slowly injected.

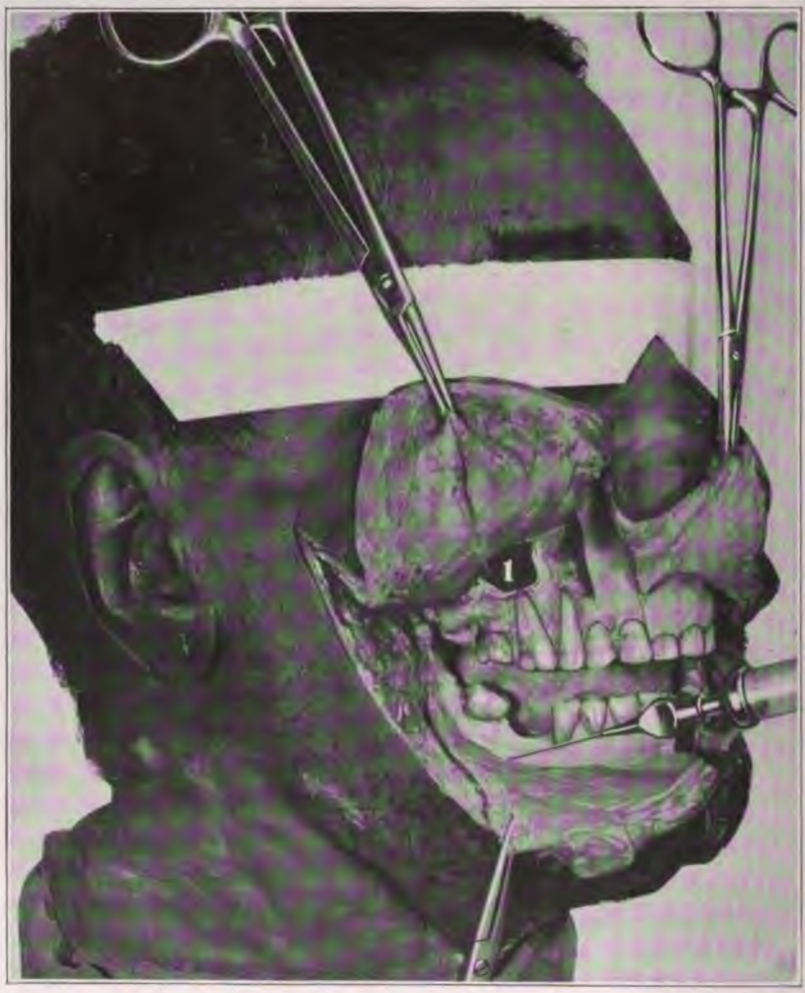


Fig. 414.—Wet specimen showing the starting of the needle in the mucosa buccal to distal root of lower second molar for anesthetizing the branches of the long buccal nerve.

1, Lateral wall of maxillary sinus removed.

The patient is now requested to bring his teeth into occlusion and to relax the cheek and lips, which will greatly facilitate the proper manipulation of the syringe. Next, hold the syringe and needle parallel to the buccal surface of the lower teeth and buccal alveolar plate. (See Figs. 416, 417, and 418.) Advance needle posteriorly 5 mm. external to the periosteum, and inject 4 minims, and wait one-half minute, then again advance the needle 5 mm., and inject 4 more minims of the solution. Repeat this procedure as often as necessary, extending the needle backward and in contact with the periosteum covering the external alveolar plate and parallel to the bucco-alveolar plate until the needle point is located posterior to the lower third molar. (See Fig. 416.)

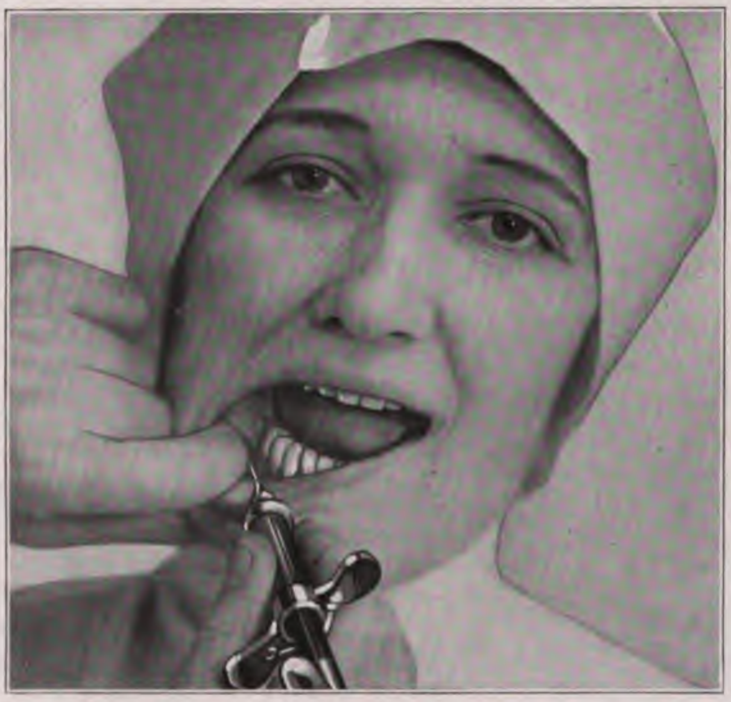


Fig. 415.—Starting the needle into the reflection of mucosa buccal to the distal root of the lower second molar with the patient's mouth open.

Always inject at least 5 minims of solution distal to the lower third molar if it is to be removed. The average depth of the needle from the starting point to the region disto-buccal to the lower third molar is approximately 2 cm. The needle should never be forced beneath the periosteum while it is being advanced posteriorly in the above described region.

BLOCKING THE LONG BUCCAL OR BUCCINATOR NERVE TO THE POSTERIOR AND INFERIOR OF THE OPENING OF STENSON'S DUCT

In case the tissues are in a state of inflammation it would be unwise to block the long buccal nerve by inserting the needle to the buccal of the lower second and third molars; therefore, in case of infection the nerve is blocked by a different method, which is in the mucosa of the cheek, 1 cm. posterior and inferior to the opening of Stenson's duct. Needle No. 4 is employed for this injection. The syringe is directed from the opposite side of the mouth and the needle is advanced posteriorly and laterally into the mucosa to an approximate depth of 1 cm., and two mils of the solution are slowly injected. (See Fig. 419.)

Locating Stenson's Duct.—Stenson's duct is easily located by the small flap of tissue which is found at the opening of the duct, or by drying the mucous membrane, and then observing the region for a few seconds, when saliva will be observed escaping from the duct. In most cases the opening of Stenson's duct is located in the cheek opposite the buccal surface of the upper second molar. (See Figs. 133, 139, and 141.) The branches of the long buccal nerve are blocked more frequently by injecting the solution into the tissues to the buccal of the lower second and third molars than by blocking the main division at a point 1 cm. posterior and inferior to the opening of Stenson's duct.

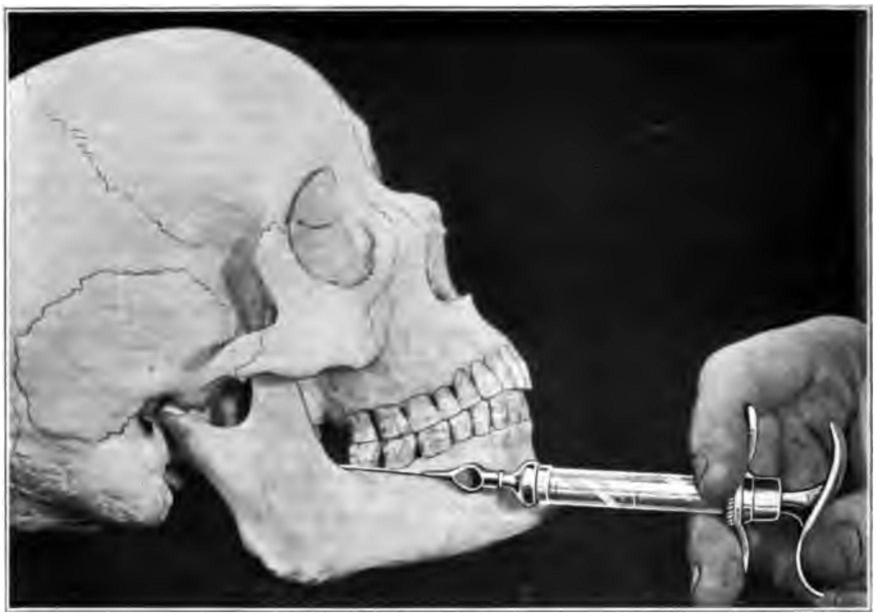


Fig. 416.—Illustrating the position of needle for blocking the branches of long buccal nerve. Note the point of needle is extended posterior to third molar.

Injection of Solution.—When the nerve is blocked by inserting the needle into the mucosa to the buccal of the lower second and third molars, the solution is injected in the following way: When the point of the needle enters the mucosa, 4 minims of the solution are injected with the patient's mouth open, then with the patient's teeth in occlusion, with lips and cheeks relaxed, the needle is gradually advanced backward in the tissue to a depth of 5 mm., and 4 more minims of the solution are injected. This procedure is repeated as often as necessary while advancing the needle in contact with the periosteum covering the external alveolar plate. If the lower third molar is to be removed, it is necessary to force the needle at least 5 mm. posterior to the lower third molar, and at that point 5 minims of the solution must be injected in order to block the long buccal branches which supply the mucosa and periosteum distal to the third molar. (See Figs. 416 and 417.) If this is not done, in many cases the incision which is made in the mucosa and periosteum above the alveolar process, which covers the impacted third molar, will give the patient considerable pain. The total quantity of solution injected is two mils. The solution should be injected slowly and sufficient time allowed between the injections and the advancement of the needle so as to make the needle insertion absolutely painless.

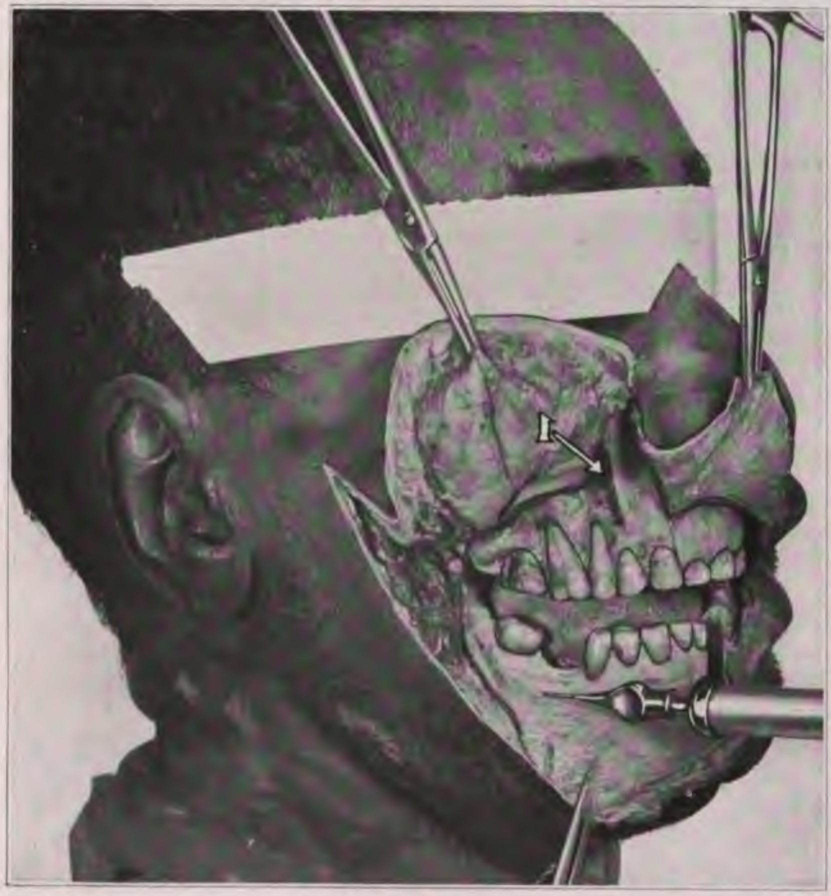


Fig. 417.—Anatomical specimen which illustrates the position of needle along the buccal alveolar plate for blocking the branches of the long buccal nerve.

1, Anterior aspect of antrum.

Injection of Solution One Centimeter Inferior-Posteriorly to Stenson's Duct for Blocking Long Buccal Nerve.—The amount of solution required for blocking the long buccal nerve 1 cm. posterior-inferiorly to the opening of Stenson's duct is 2 mils. If necessary, the solution may be deposited continuously from the time the needle enters the mucosa until a depth of 1 cm. has been reached. However, it will be found that this is seldom necessary, inasmuch as little or no pain is experienced by the patient while the needle is being advanced into the tissue.

Precautions.—The patient's mouth should be open while the needle is being started into the mucosa so that the operator has a clear view of the tissues. After starting the needle the patient's teeth should be in occlusion with the lower lip relaxed as shown in Fig. 418. This will facilitate the free movement of the syringe while extending the needle in the proper direction, and there will be no danger of bending or breaking it. In some individuals the external oblique line is very prominent where it joins the alveolar process covering the lower third molar, and in such a case the point of the needle may strike the anterior surface of this bony landmark, and if this is done, the barrel of the syringe should be carried downward and laterally which will change the direction of the needle to that of upward and inward. In other words, the needle will pass to the lingual of the external oblique line. (See Fig. 416.) If

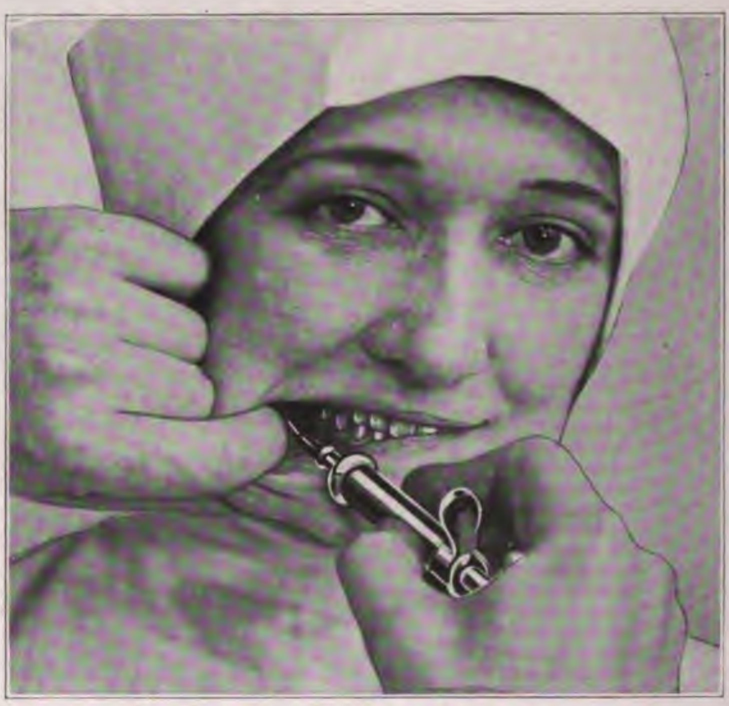


Fig. 418.—Injecting the solution at various intervals for blocking the branches of the long buccal nerve, as the needle is advanced backward with patient's mouth closed.

this position is assumed by the needle, it will not be parallel to the occlusal plane of the lower third molar, but will form an angle with the occlusal surface. Four minims of solution should be deposited at intervals of 5 mm. from the time the needle enters the mucosa buccal to the distal root of the lower second molar until it reaches a point distal to the lower third molar. Always inject to the distal of the lower third molar if it is to be operated, which will anesthetize the mucosa and periosteum distally to the region of this tooth. It is not necessary to force the needle beneath the periosteum while making this injection, because when the solution is injected external to the periosteum it produces almost immediate anesthesia of the branches of the long buccal nerve.

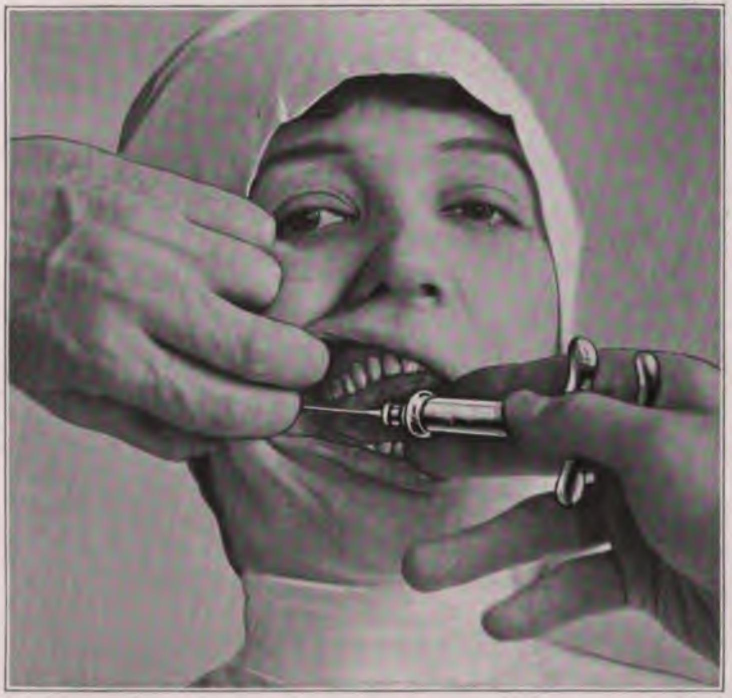


Fig. 419.—Illustrating position of syringe for blocking the long buccal nerve. The puncture point is located 1 centimeter below and posterior to opening of Stenson's duct.

Time to Wait for Anesthesia.—Profound anesthesia is secured within one minute following the injecting of solution for long buccal nerve.

Structures Anesthetized.—The tissues anesthetized depend upon which injection is made. If the solution is injected to the buccal of the lower second and third molars, the following tissues are anesthetized: mucosa and periosteum distal to the lower third molar, gum tissue, periosteum which covers the bucco-alveolar plate of the lower second and third molars, and in addition the mucosa at the reflection between the cheek and gum tissue. If the long buccal nerve passes farther anteriorly than the lower second molar, namely, in the region of the lower first molar, which is sometimes the case, then, the tissue in that region would also be blocked. (See Fig. 420.)

If the long buccal nerve is injected at a point one centimeter inferior-posteriorly to the opening of Stenson's duct, a greater amount of tissue is blocked than by the other block method. In addition to the tissues located to the buccal and distal of the lower first, second and third molars, the mucosa at the reflection between the cheek and gum tissue, and also a considerable area of the cheek are blocked. *It should be borne in mind that the long buccal nerve does not supply the alveolar process, teeth, or the lingual tissue. It is not necessary to block this nerve for dental operations, such as pulp removal, cavity preparation, etc.* If the second and third molars are to be extracted, or if the operation should involve the buccal tissues, then in 75 per cent of the cases it is essential to block this nerve branch. In those cases in which the long buccal nerve supplies the buccal structures and it is not anesthetized, the application of the buccal beak of the forceps would inflict pain even if the inferior dento-lingual nerves were thoroughly blocked.

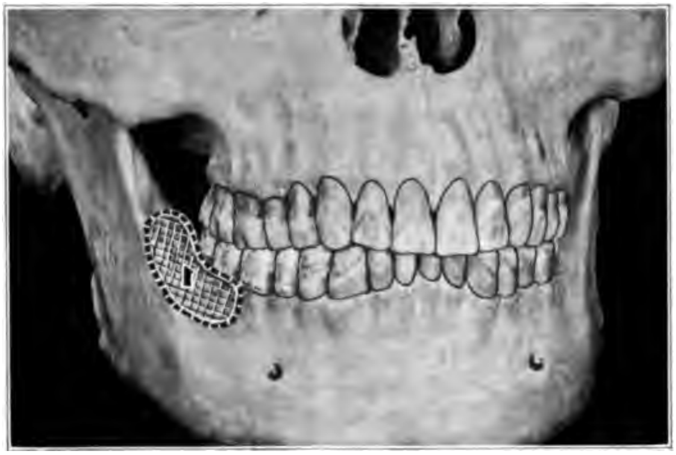


Fig. 420.—Illustrating the area which is anesthetized by the long buccal injection when the solution is deposited buccal to the second and third lower molars.

Determining When Necessary to Block the Long Buccal Nerve Following an Inferior Dento-lingual Blocking.—After the inferior dento-lingual injection has been made, and if a sufficient time has elapsed to secure anesthesia of the parts, the operator should test the tissues to see whether or not profound anesthesia has been obtained. The operator should first test the case by exerting direct pressure upon the gum tissue to the buccal of the lower first and second bicuspid teeth. If the patient should experience pain it is caused by one of the following factors: (1) Sufficient time has not elapsed to allow the solution to produce deep anesthesia of the inferior dental nerve, or (2) that the solution has been improperly injected. If the latter factor is the cause, deep anesthesia will never be secured. If the patient should experience pain in the buccal tissues of the lower bicuspid teeth the operator should wait a few minutes and then test the case again. On testing the case a second time, if the patient still experiences pain, it should prove that the solution has not been properly injected for blocking of the inferior dental nerve, and the injection should be repeated. In case the buccal tissue as the instrument is extended backward. If such pressure is made strument should be carried backward over the gum tissue covering the lower first, second and third molars. Sharp pressure should be made upon the tissue as the instrument is extended backward. If such pressure is made upon the buccal tissues to a point distal of the lower third molar without causing pain, it signifies that the long buccal branches do not enter this area, and that anesthesia of the inferior dental nerve is complete, and the blocking of the long buccal nerve is necessary. However, if the buccal tissues of the lower bicuspids are anesthetized, and the patient experiences pain when the instrument is applied to the buccal tissues of the lower second and third molars, it signifies that the long buccal nerve supplies this area, in addition to the inferior dental nerve, and must be blocked. In approximately 75 per cent of cases the buccal tissues in the region of the lower second and third molars are supplied by nerves from two different sources, that is, from the inferior dental and long buccal. In approximately 5 per cent of cases the buccal surface of the lower first molar is supplied from the two different sources as mentioned above. The author does not advise making the long buccal injection until the time of operating. If it is then found necessary after testing the area, the injection is made. No time is lost in waiting for anesthesia following this injection because anesthesia is in most cases complete within one minute. However, in some cases, it is good practice to make the long buccal injection immediately following the blocking of the inferior dento-lingual nerves. For example, if the patient is to be referred to another office for extraction of the teeth, or for the performance of some other operation, it is always best to make sure that the parts are thoroughly blocked before dismissing the patient.

When and when not to make the long buccal injection has been somewhat of a puzzle to many operators, and this very injection has caused many dentists to fail with block anesthesia in the region supplied by these nerves. The writer has been advised by many operators that after they made the inferior dento-lingual injection they found the buccal tissues in the region of the lower second and third molars to be highly sensitive, and in many cases they injected more solution to block the inferior dento-lingual nerves more thoroughly. Very much to their surprise, after making the second injection, the buccal tissues still remained sensitive. This was due to these tissues being supplied, in addition to the inferior dental nerve, by the long buccal nerve, and if several inferior dento-lingual injections were made the buccal tissues would still remain sensitive. Evidently those operators did not understand their anatomy, or they would have known that the long buccal nerve was causing the trouble and would have made the long buccal injection.

Blocking the Interlacing or Overlapping Branches.—It is not necessary to block any of the interlacing or overlapping branches of the long buccal nerve, except the inferior dental supplying the buccal surface of the lower second and third molars which have been previously discussed.

BLOCKING THE MENTAL AND INCISIVE NERVES AT THE MENTAL FORAMEN

Topography of Anatomy.—For a detailed description of the mental nerve see Chapter VII. The inferior dental canal becomes smaller as it passes anteriorly. The apices of the bicuspid roots are located a greater distance above the canal than the apices of the molar roots. The inferior dental nerve continues anteriorly in the inferior dental canal, giving off small branches which enter the apices of the roots of the lower molars (see Figs. 60 and 69) and, as it reaches a point near the mental foramen, it divides into two terminal branches, the mental and incisive (see Figs. 107 and 111). The incisive nerve continues anteriorly in the mandible supplying the alveolar process, a portion of the bone comprising the mandible, cuspid, lateral and central incisor teeth, labial periosteum, gum tissue and mucous membrane. The mental nerve passes out of the mental foramen and divides into the anterior and posterior rami (see Fig. 112). The mental nerve does not supply the teeth, alveolar process, or bone, but the buccal tissues located in the region of the mental foramen. Therefore, the injecting of the mental nerve does not anesthetize the alveolar process or two lower bicuspid teeth. All nerve blocking injections should take the name of the nerve branch that is blocked, and when this injection is given the name of "mental," it is incorrect. It is true that the solution is injected at the opening of the mental foramen, the mental nerve and its branches being blocked, but the principal object of injecting the solution at the foramen is to anesthetize a portion of the inferior dental

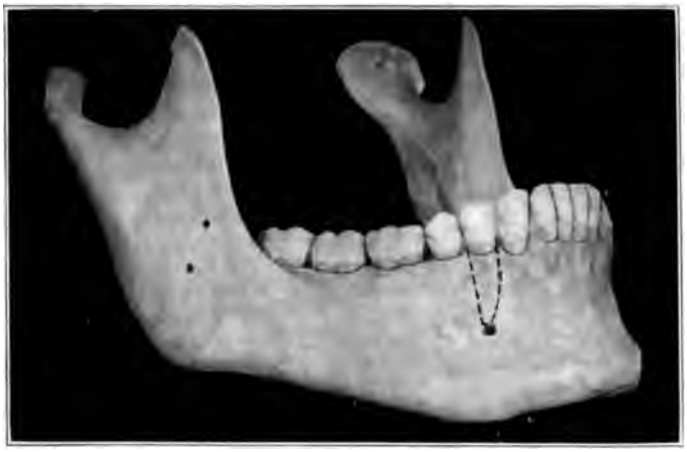


Fig. 421.—Mental foramen located below the apex of first bicuspids (5 per cent of cases).

nerve and the incisive branch, or the region where the inferior dental divides into its terminal divisions, the incisive and mental branches. Therefore, it appears that a more appropriate term would be to call this injection the "mental-incisive injection," rather than the mental injection.

The object of injecting the solution at the opening of the mental foramen is to anesthetize the two lower bicuspid teeth, alveolar process, and buccal structures in this region, and to block the nerve supply in conjunction with the incisive, mental or inferior dental injections on the opposite side.

In the adult the mental foramen is located in most cases approximately midway between the lower border of the mandible and the gingival margin in the bicuspid region. (See Fig. 425.) The author has found, after examining several hundred skulls, that the location of the mental foramen is as follows: in 5 per cent it is situated below the apex of the first bicuspid root (see Fig. 421); in 50 per cent below and between the apices of the first and second bicuspid roots (see Fig. 422); in 25 per cent below the apex of the second bicuspid root (see Fig. 423); and in 20 per cent below and slightly posterior to the apex of the second bicuspid root (see Fig. 424). From the above named positions, it can be seen that the mental foramen varies considerably in its location. However, it is easily located in most cases by the method described under technic.

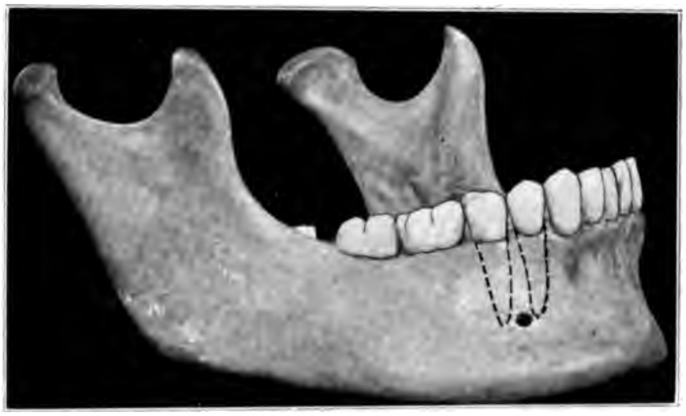


Fig. 422.—Mental foramen located below and between the apices of the first and second bicuspids (50 per cent of cases).

The diameter of the mental foramen is in the average case 2½ mm.; it extends through the external alveolar plate; opens distally and laterally, and its anterior surface has a sharp margin, whereas the posterior surface is either flat or round (see Fig. 35). The anterior ramus of nerve is in contact with the anterior sharp margin, and when pressure is exerted on the tissues directly over this point, the patient experiences a slight sharp pain; this is one of the methods of locating this bony landmark. If a transverse line is drawn from the anterior external margin of the mental foramen on the right side to the same landmark on the opposite side, this line will be approximately 1 cm. shorter than a transverse line drawn from the buccogingival margin of the lower second bicuspid to a similar landmark on the opposite side. The anatomical shape of the mandible in this region is such that there is considerable difference in the length of the two lines drawn on the two transverse planes above given. This is important for the reason that it is difficult or impossible to reach the mental foramen by advancing the needle in contact with the periosteum above the mental foramen during its passage through the tissue.

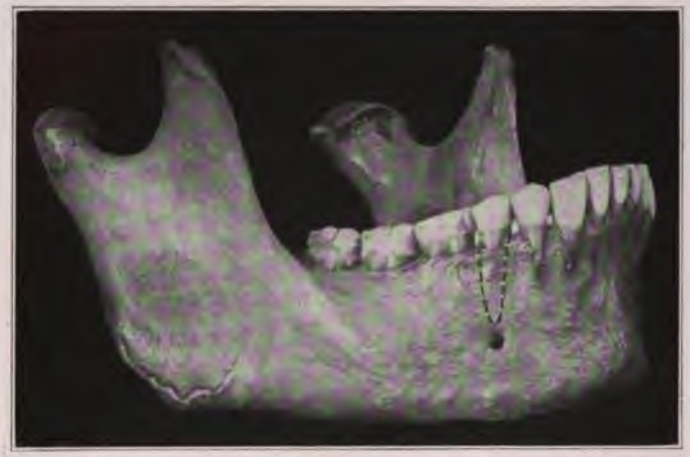


Fig. 423.—Mental foramen located below the apex of second bicuspid (25 per cent of cases).

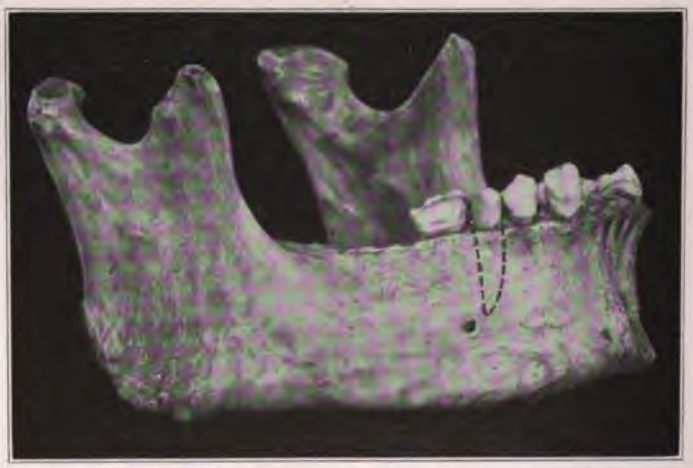


Fig. 424.—Mental foramen located below and posterior to the apex of second bicuspid (20 per cent of cases).

During a meeting of the Kansas State Dental Association Dr. Frank O. Hetrick, of Ottawa, Kansas, brought the author a skull showing a well developed mental foramen situated beneath the second molar tooth, which is an unusual exception to the normal position of this foramen. In a small percentage of cases two or more foramina may be found. Figs. 69 and 107 show a supernumerary mental foramen transmitting a nerve branch. On close examination of the nerve supply in this specimen, it was found that the mental nerve was given off as usual from the inferior dental nerve, and then the mental nerve divided into three branches, that is, the anterior and posterior

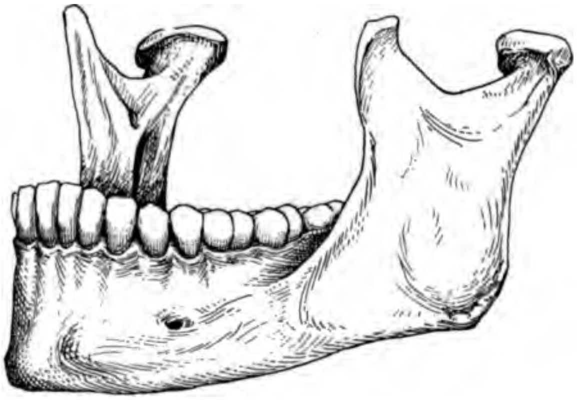


Fig. 425.—Location of mental foramen in an adult, midway between the buccal gingival margin and lower border of mandible, and below and between the apices of the lower bicuspids.

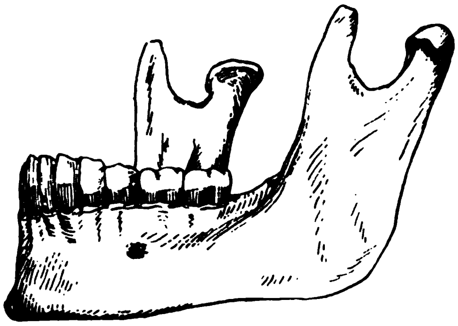


Fig. 426.—Location of mental foramen in a child below and between the roots of the first and second deciduous molars.

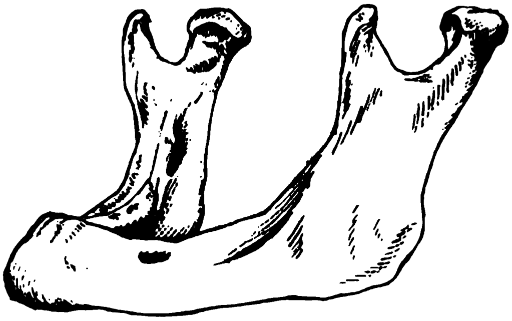


Fig. 427.—Location of mental foramen in senile jaw.

rami which were normal, and the third branch which was supernumerary, and passed out of an independent foramen. These two foramina are 1 cm. apart.

Needle Employed.—The needle employed for blocking the mental and incisive nerve branches at the mental foramen is No. 4, 25 gauge, and 30 mm. in length (see Fig. 177).

Technic of Injection.—The chair should be lowered and the patient assume a semisupine position, with the operator standing behind the patient. Before preparing the tissue for the needle, the location of the mental foramen is ascertained. To locate the mental foramen, the following methods are employed: The patient's lips and cheeks should be depressed, and the operator should observe the general location of the bicuspid teeth which will give him an approximate location of the mental foramen. Place the tip of the index finger on the skin exterior to the apices of the roots of the lower bicuspid teeth. (See Figs. 428 and 429.) The tip of the index finger is moved gently, and in most instances the pulsation of the mental artery can be obtained. However, in some cases this is difficult, if there is considerable muscle and adipose tissue present in this region. Usually the foramen is located by placing the tip of the index finger in the approximate location of the foramen and exerting considerable pressure on the skin and underlying tissue. Maintaining this pressure continuously, the index finger is moved slightly, and when pressure is exerted directly over the anterior

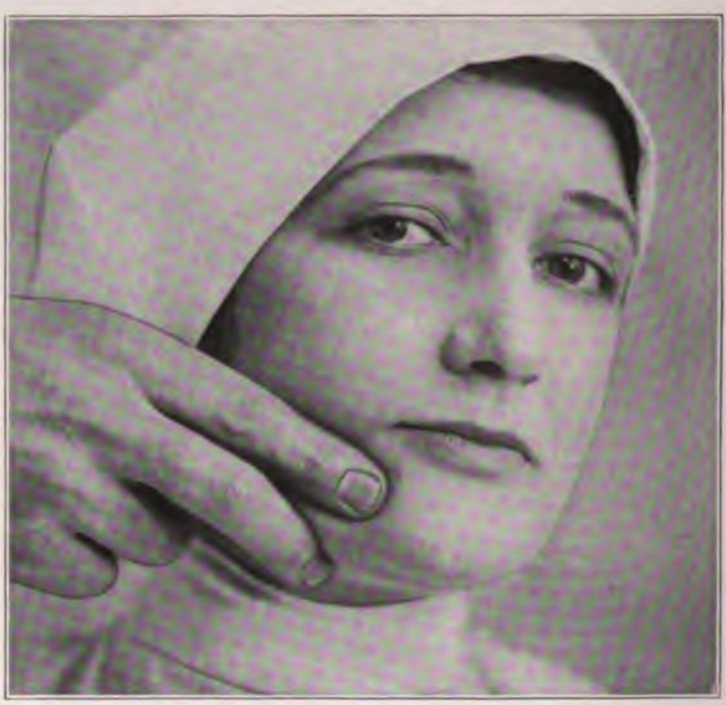


Fig. 428.—Locating the mental foramen by palpating the tissues with the tip of index finger.

ramus of the mental nerve (which is in contact with the anterior sharp margin of the mental foramen) the patient will experience a slight sharp pain. Before this procedure the patient should be informed to advise the operator the moment he experiences a difference in the sensation. This direct pressure is an excellent guide in locating the mental foramen. Therefore, by these three methods: *First,* observation; *second,* palpation, and *third,* direct pressure, little difficulty will be experienced in locating the mental foramen, and after this is accomplished the injection of the solution is a very simple matter.

After the foramen is located, the operator should compare the external position of the index finger, as it is resting over the mental foramen, with the bicuspid teeth. Next prepare an area 3 cm. in diameter with the germicidal solution over the buccal surfaces of the gum tissue and mucosa in the region of the two lower bicuspid teeth. The operator stands behind the patient, the chair lowered, with the patient in a semisupine position. The tip of the left index finger is placed over the mental foramen, the cheek and lip are depressed with the thumb (see Fig. 429). The patient is instructed to keep the mouth about one-half open, the syringe is held in the hand pen fashion, and should contain at least two mils of the injecting solution. The barrel of the syringe is in contact with the patient's cheek, and with the cheek drawn laterally and the lip depressed, the area of injection is in

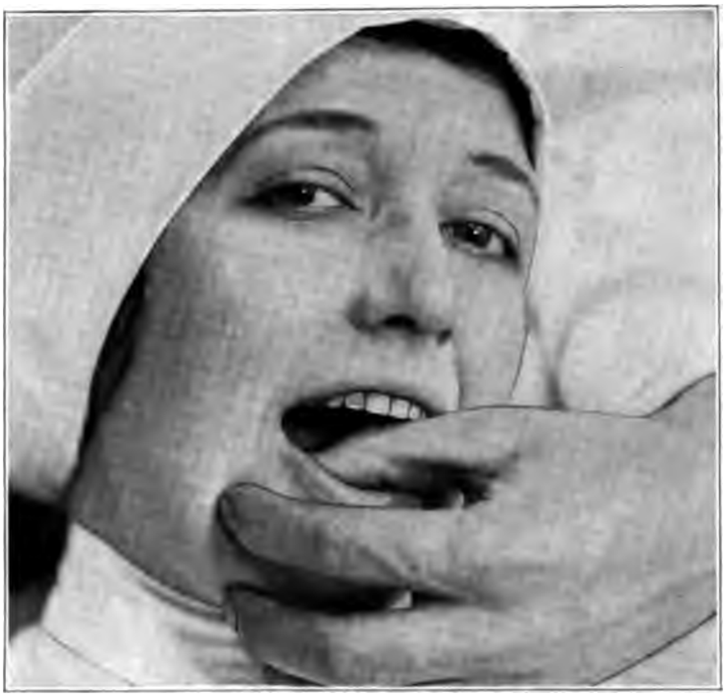


Fig. 429.—After locating the mental foramen the tip of index finger is allowed to remain over same. The cheek and lip are depressed with the thumb.

full view. The mucous membrane is punctured with the needle at a point between the cheek and gum tissue, or at the lowest point buccal to the lower second bicuspid tooth. Great stress should be laid on the importance of puncturing the mucosa buccal to the second bicuspid tooth. (See Figs. 431 and 432.) Do not insert the needle into the gum tissue, for if this is done, it may be forced beneath the periosteum and never reach the mental foramen. When the needle is started into the mucous membrane it should be at least 1 cm. from the periosteum covering the external alveolar plate (see Fig. 433). The needle should never be in contact with the periosteum until the opening of the mental foramen is reached. The direction of the needle, after the initial puncture is made, depends on the location of the mental foramen. Fig. 434 shows the four positions of the mental foramen, and also indicates the position assumed by the needle as it passes through the tissues. A common start-

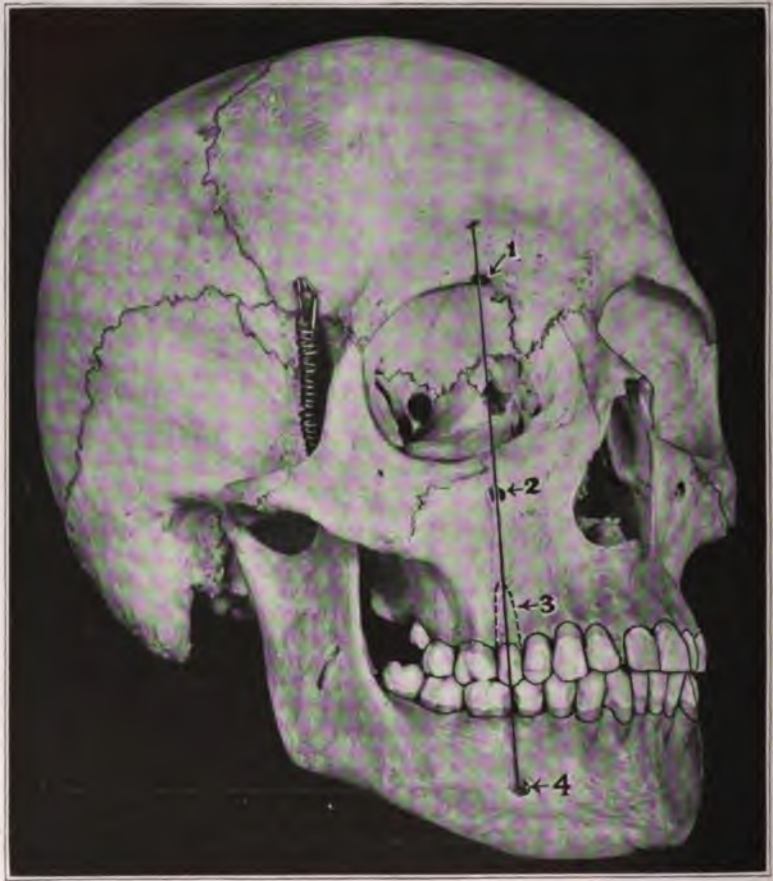


Fig. 430.—Illustrating a line drawn through the long axis of upper second bicuspid passing through the following:

1, Supraorbital foramen or notch; 2, infraorbital foramen; 3, route of upper second bicuspid; 4, mental foramen.

ing point is employed which is located in the mucous fold to the buccal of the lower second bicuspid (see Figs. 431 and 434). If the position of the mental foramen is found to be below the apex of the first bicuspid, the needle is directed towards the foramen, which would be anteriorly, inward and downward. If the foramen is situated below and between the apices of the bicuspid teeth, the needle is inserted downward, inward and anteriorly (see Figs. 435 and 436). If the foramen is beneath the apex of the second bicuspid, the needle is advanced downward and inward (see Fig. 437), and if it is located

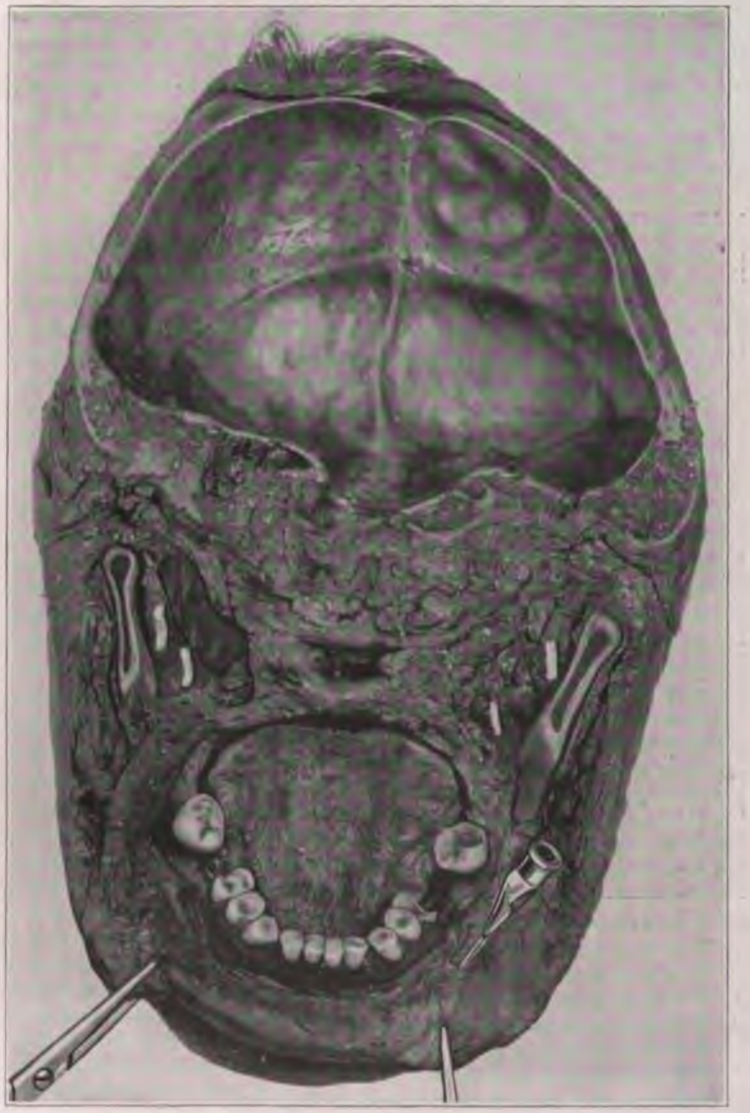


Fig. 431.—Illustrating puncture point for mental injection, located buccal to second bicuspid.

solution from the syringe, and if this is experienced by the operator, the needle should be slightly withdrawn and its position changed. If the needle is manipulated as previously described, the solution can be injected with perfect ease, without pain, and little or no difficulty will be experienced, the needle striking the periosteum before the opening of the foramen is reached.

Massaging the Tissues.—After the solution is injected, the skin which covers the region of the mental foramen should be massaged, using a circular movement, to enable the solution to penetrate the mental foramen and reach the inferior dental nerve, where the mental and incisive branches arise. The solution must pass through the mental foramen to produce anesthesia of the two lower bicuspid teeth (50 per cent of cases the cuspid), alveolar process and buccal structures. A skillful technic is necessary if the solution is to be injected at the opening of a foramen, such as the mental or infraorbital, because the solution must pass a distance of several millimeters to reach the desired nerve branches. Therefore, the operator must remember that if the solution is not injected at the opening of the foramen, very little of it will ever reach the desired point, even if the area is properly massaged.

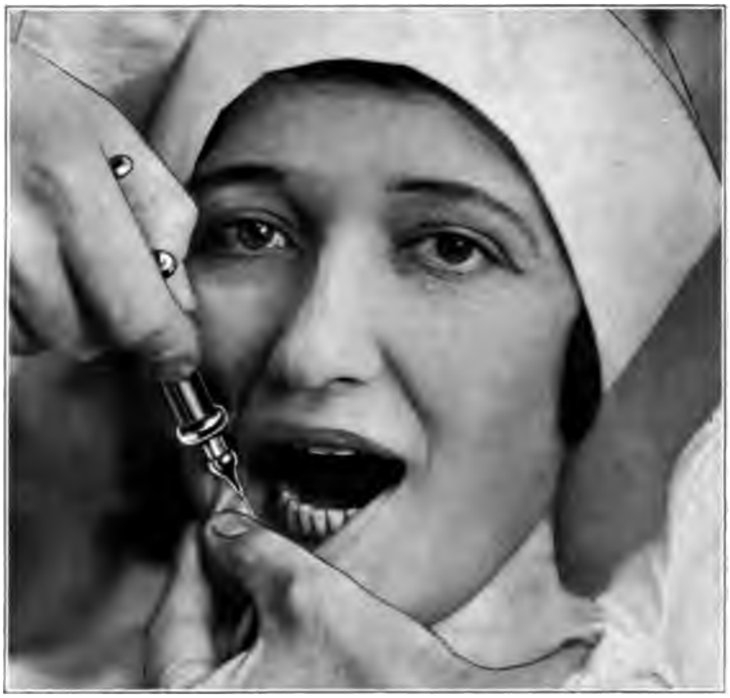


Fig. 433.—Injecting the solution at the mental foramen.

Precautions.—Always locate the position of the mental foramen before preparing the tissue for the reception of the needle. Never extend the needle downward in contact with the periosteum for fear of bending or breaking it

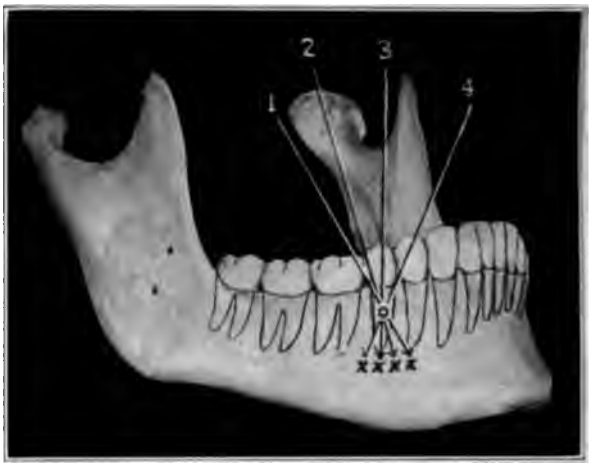


Fig. 434. Various directions of needle for depositing solution at mental foramen. X. Represents various positions of mental foramen. O. Represents common starting point of needle. 1. Direction of needle when foramen is located beneath first bicuspid; 2, when below and between bicuspids; 3, when below second bicuspid; 4, when below and distal to second bicuspid.

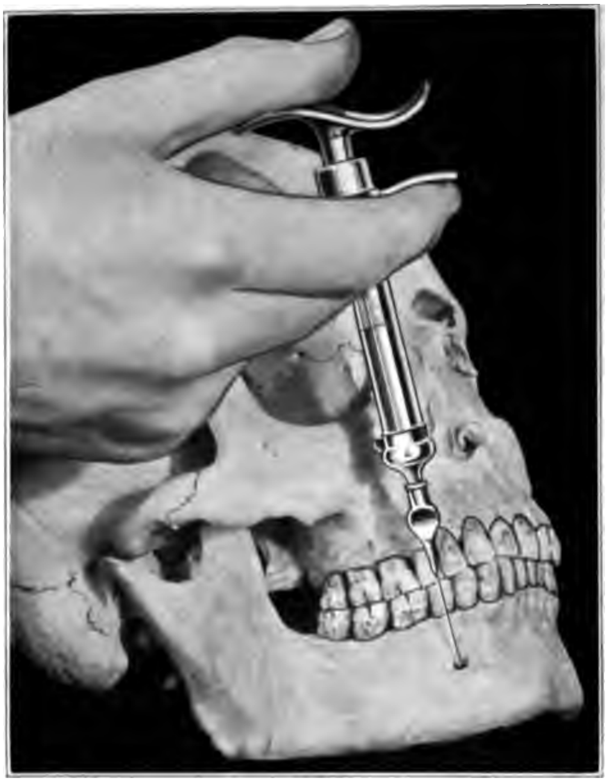


Fig. 435. Injecting solution at mental foramen when located below and between apices of bicuspids. Needle directed downward, inward and slightly anteriorly.

solution from the syringe, and if this is experienced by the operator, the needle should be slightly withdrawn and its position changed. If the needle is manipulated as previously described, the solution can be injected with perfect ease, without pain, and little or no difficulty will be experienced, the needle striking the periosteum before the opening of the foramen is reached.

Massaging the Tissues.—After the solution is injected, the skin which covers the region of the mental foramen should be massaged, using a circular movement, to enable the solution to penetrate the mental foramen and reach the inferior dental nerve, where the mental and incisive branches arise. The solution must pass through the mental foramen to produce anesthesia of the two lower bicuspid teeth (50 per cent of cases the cuspid), alveolar process and buccal structures. A skillful technic is necessary if the solution is to be injected at the opening of a foramen, such as the mental or infraorbital, because the solution must pass a distance of several millimeters to reach the desired nerve branches. Therefore, the operator must remember that if the solution is not injected at the opening of the foramen, very little of it will ever reach the desired point, even if the area is properly massaged.

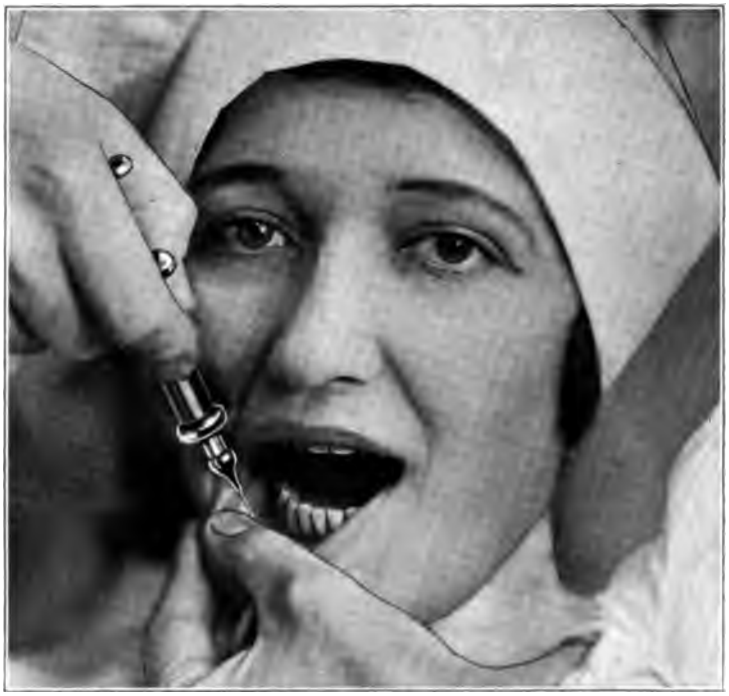


Fig. 433.—Injecting the solution at the mental foramen.

Precautions.—Always locate the position of the mental foramen before preparing the tissue for the reception of the needle. Never extend the needle downward in contact with the periosteum for fear of bending or breaking it

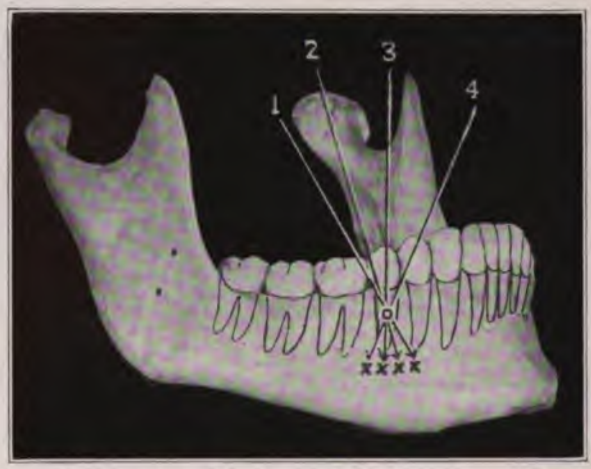


Fig. 434.—Various directions of needle for depositing solution at mental foramen. X. Represents various positions of mental foramen. O. Represents common starting point of needle. 1, Direction of needle when foramen is located beneath first bicuspid; 2, when below and between bicuspids; 3, when below second bicuspid; 4, when below and distal to second bicuspid.

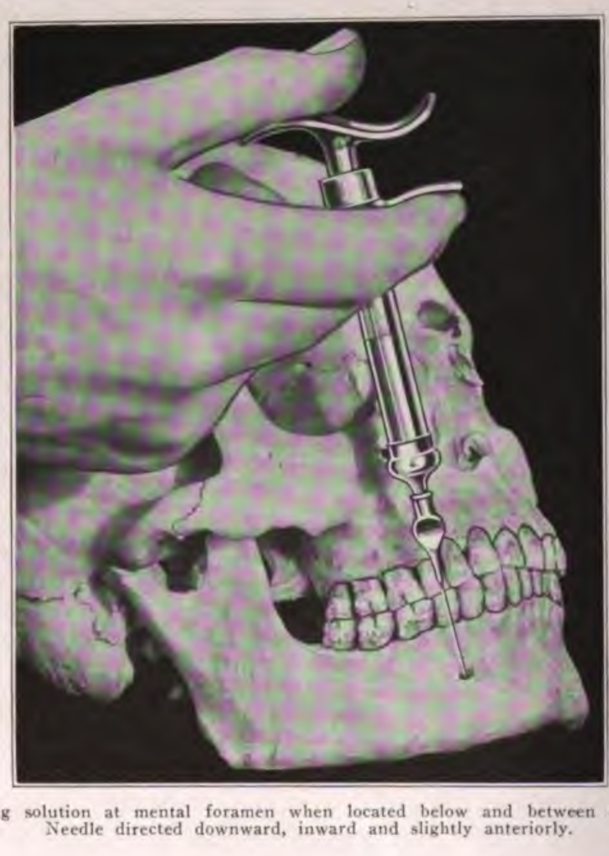


Fig. 435.—Injecting solution at mental foramen when located below and between apices of bicuspids. Needle directed downward, inward and slightly anteriorly.

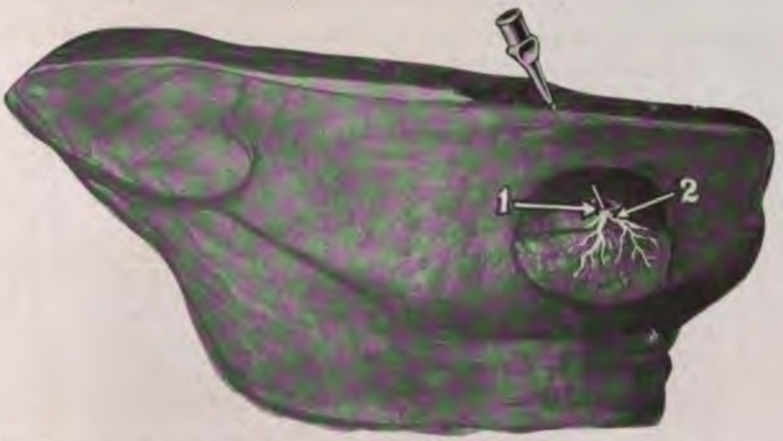


Fig. 436.—Illustrating direction of needle for injecting solution at mental foramen, when located below and between apices of bicuspids.
1 and 2, Mental nerve.

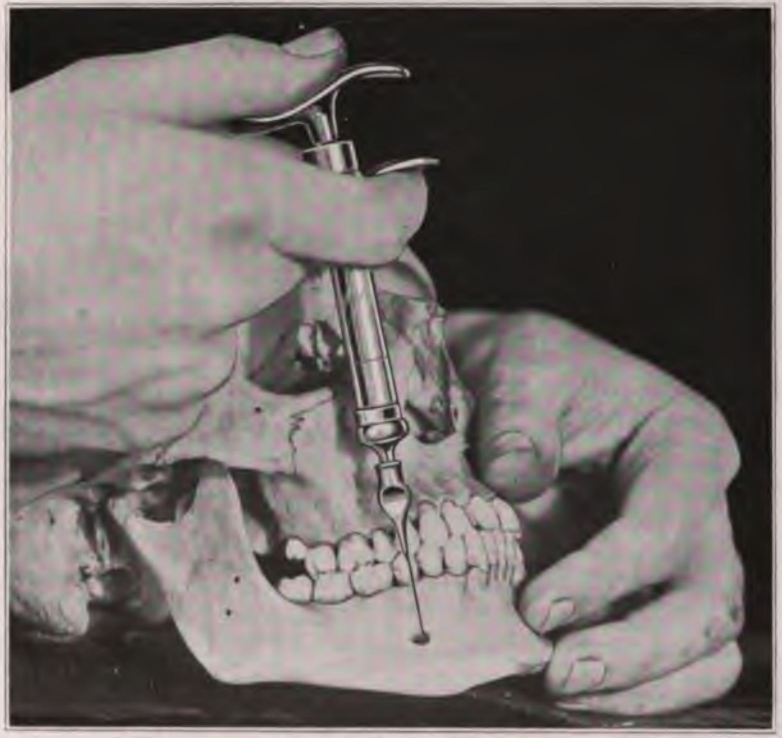


Fig. 437.—Injecting solution at mental foramen, when located below apex of second bicuspid. Needle directed downward and inward.

before the opening of the mental foramen is reached. It will be noted that considerable stress is placed on this point, as many operators have failed to produce anesthesia of this region with the mental injection. If the solution is deposited five to ten millimeters from the foramen, very little will pass into the inferior dental canal, as the solution during the process of massaging will follow the lines of least resistance, which are the soft tissues. The needle employed for this injection is No. 4, 3 cm. in length. The average depth to insert the needle is 1 cm.; therefore, 2 cm. will remain outside the tissue.

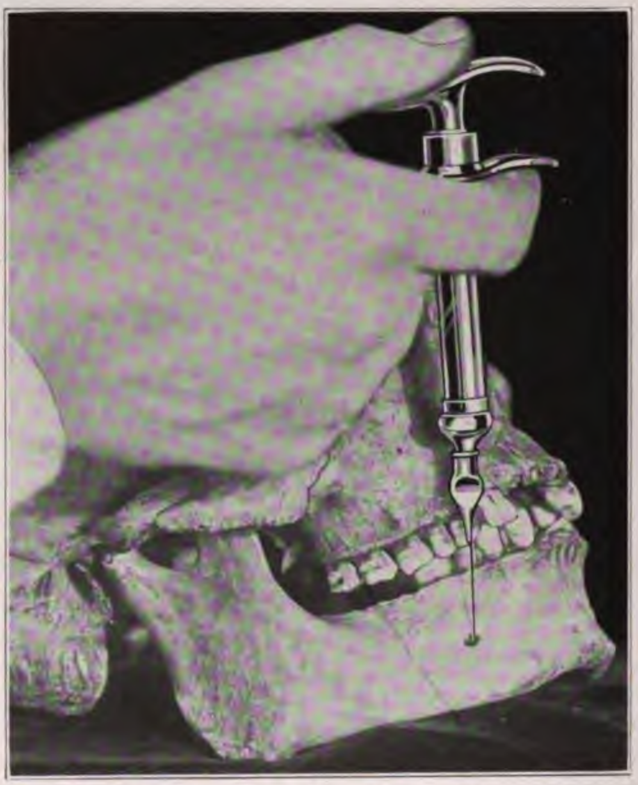


Fig. 438.—Injecting solution at mental foramen when located below and distal to apex of second bicuspid. Needle is directed downward, inward and slightly backward.

Time to Wait for Anesthesia.—The time to wait for anesthesia depends upon the four factors given on page 196. If the solution has been properly injected at the opening of the mental foramen, and the tissues covering the region massaged in a circular manner, the time will vary from three to five minutes.

Structures Anesthetized.—A single mental injection, if properly made, should anesthetize the first and second bicuspids, and in 50 per cent of the cases the cuspid, the alveolar process, buccal periosteum, gum tissue and mucosa in the reflection of the cheek, extending anteriorly as far as the labial surface of the lower cuspid. Following three different injections by the author, anesthesia was secured of the cuspid, first and second bicuspids, first and second molar teeth. The solution was injected through the mental foramen, and anesthesia was secured over a greater area on account of the solution passing both anteriorly and posteriorly in the inferior dental canal. It is not the object to force the needle into the mental foramen, but it should be stopped at the opening and the solution injected at that point. In 50 per cent of the cases, anesthesia will be secured in the cuspid sufficient for sensitive cavity preparation. However, if sufficient anesthesia has not been secured in the cuspid, the overlapping or communicating branches on the opposite side are blocked by making the incisive injection on the same side on which the mental injection was made.

If the bicuspid teeth are to be extracted, or treated for pyorrhea, or any operation which involves the lingual side, then it is essential to block the lingual nerve, as it supplies the gum tissue, periosteum and mucus membrane on the lingual side of the bicuspid teeth. The technic for blocking the lingual nerve supply that accompanies the mental injection, is described on page 619.

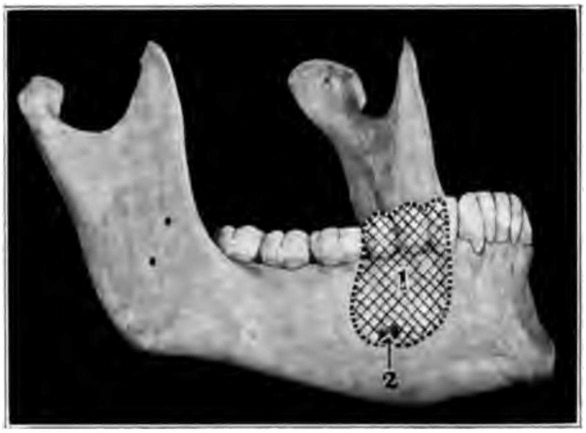


Fig. 439.—1, Outline of area of anesthesia produced by making injection at mental foramen; 2, mental foramen.

Indications and Contraindications for the Mental Injection.—The mental injection is indicated when the bicuspid teeth are involved, or in case it is desired to block the communicating nerve supply in the region of the mental foramen. This is employed many times in conjunction with the incisive, mental or inferior dental injections on the opposite side of the jaw. When the nerve supply is blocked at the mental foramen, the area of anesthesia is restricted to a smaller area than that which would be produced following the inferior dental injection.

The mental injection is contraindicated, if it is impossible to locate the position of the mental foramen, or if the tissues through which the needle must pass are inflamed, or infected.

Blocking the Interlacing or Overlapping Branches.—The deep block injections, which are usually given to anesthetize the nerve supply from the opposite side, is the mental injection on the opposite side of the arch, or the incisive injections either in the right or left incisive fossa. For example, if it is desired to produce anesthesia of the lower cuspid tooth, in addition to the mental injection, an incisive injection is made in the incisive fossa on the same side of the jaw. This will block the incisive nerve branches which enter this region from the opposite side. These two injections will isolate the area occupied by the lateral, cuspid, and first and second bicuspid teeth.

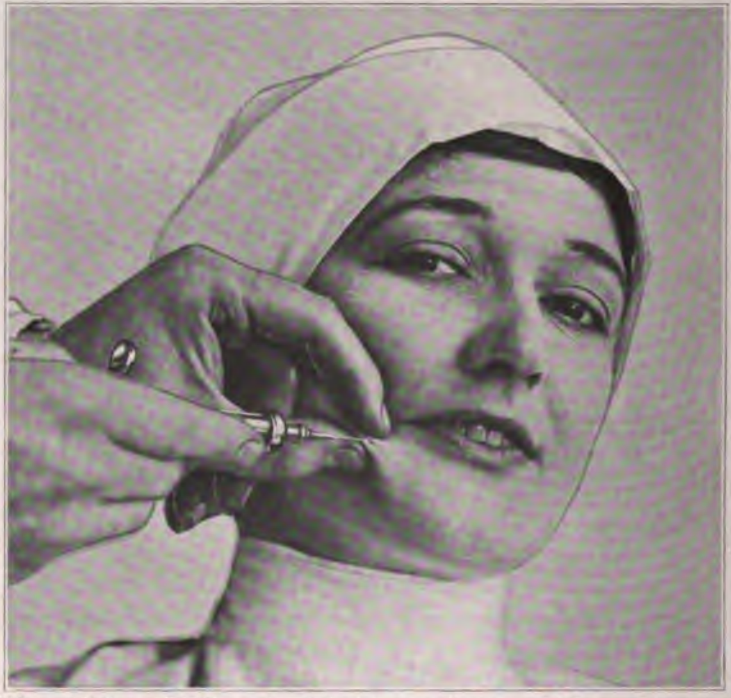


Fig. 440.—Making preliminary injection prior to inserting needle to mental foramen by extraoral method.

BLOCKING THE MENTAL AND INCISIVE NERVES BY THE EXTRA-ORAL METHOD

Topography of Anatomy.—The nervous anatomy of this region has been given in Chapter VII. The needle is inserted from the exterior through the skin and buccal tissues. The same rules apply here for locating the mental foramen as those which have been given on page 596 under technic for blocking the mental incisive nerves by the intraoral method, and the reader is advised to refer to that part of the text.

Needle Employed.—Two needles are used for blocking the mental incisive nerves at the mental foramen by the extraoral method. Preliminary needle No. 7 is used for injecting into the skin and subcutaneous tissue, followed by needle No. 4 for injecting the solution at the opening of the mental foramen.

Technic of Injection.—The skin is first prepared by the application of a germicidal solution, such as tincture of iodin or a 1/1000 solution of bichloride of mercury. The chair is lowered and the patient is placed in the semisupine position, the operator standing behind the patient. The skin is held between the index finger and thumb, and the preliminary needle, which is 10 mm. in length, 27 gauge, is passed beneath the surface of the skin, and 4 minims of solution are slowly injected. (See Fig. 440.) After waiting for one minute, the needle is gradually advanced into the skin and subcutaneous tissue, and 4 more minims of solution are injected. The process is repeated as often as necessary. Be careful to inject the solution both within and beneath the skin. At least, two minutes should elapse following the preliminary injection, to allow the solution sufficient time to produce deep anesthesia of the skin and subcutaneous parts, so the regular nerve blocking needle can be inserted without pain. The syringe, with needle No. 4, is held in the hand pen fashion and the puncture is made in the skin 2 cm. posterior and inferior to the angle of the mouth, in the tissue which has been anesthetized by the preliminary injection. (See Fig. 441.) The direction of the needle is downward, inward and either posteriorly or anteriorly, this depending upon the position of the foramen. (See Figs. 421, 422, 423, and 424.) The needle should not strike the periosteum covering the external al-

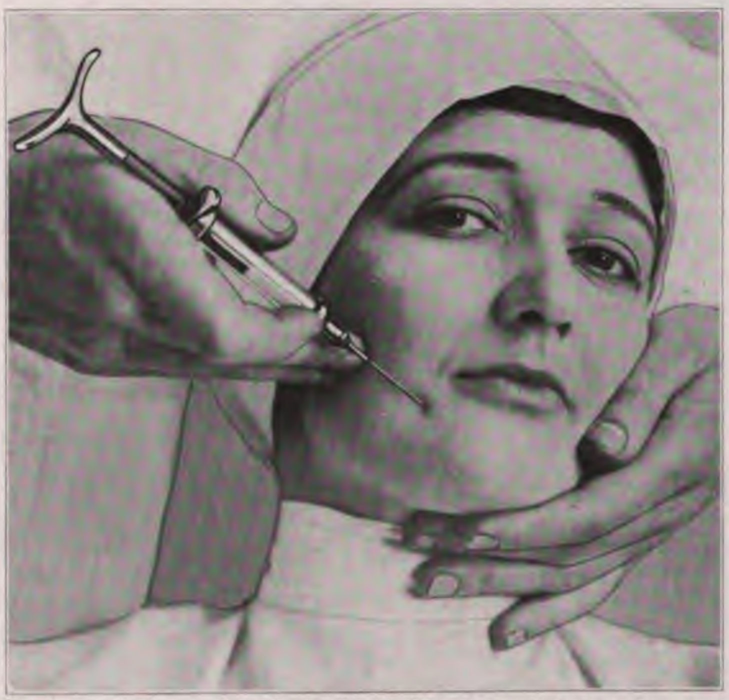


Fig. 441.—Starting needle in anesthetized zone for blocking at mental foramen by extraoral method.

veolar plate until the opening of the mental foramen is reached. The needle forms an acute angle with the external alveolar plate while the solution is being injected. (See Figs. 442, 443, and 444.)

Injection of Solution.—The skin is held between the index finger and thumb, the preliminary needle is inserted beneath the surface, and one-half mil of solution is injected between the skin and muscle tissue. The syringe should contain 2½ mils of solution, which are sufficient for the preliminary injection and the amount that is to be discharged at the opening of the mental foramen. Two mils of the solution are discharged at the opening of the mental foramen. (See Figs. 443 and 444.) If the patient experiences pain as the needle is being advanced, it is good practice to inject solu-

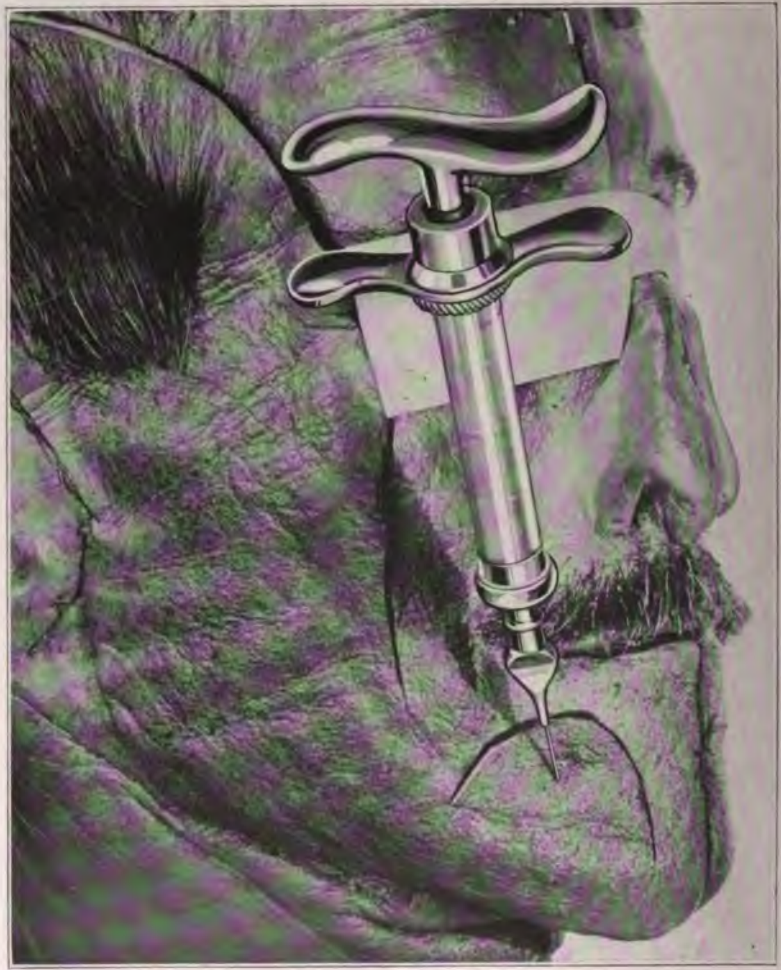


Fig. 442.—Wet anatomical specimen showing direction of needle while injecting the solution at mental foramen by extraoral method.

tion at any time during its passage. The solution should be injected very slowly and the tissues massaged over the mental foramen in a circular manner. (See page 601 under Intraoral Method.)

Precautions.—Never insert the nerve blocking needle into the skin and other tissues until a preliminary injection has been made. While needle No. 4 is of very small diameter, considerable pain will be experienced unless there has been a preliminary injection, or the skin frozen by ethyl chlorid or some other refrigerant agent. Due care should be taken in locating the mental foramen before inserting the needle into the tissue. Never attempt to advance the

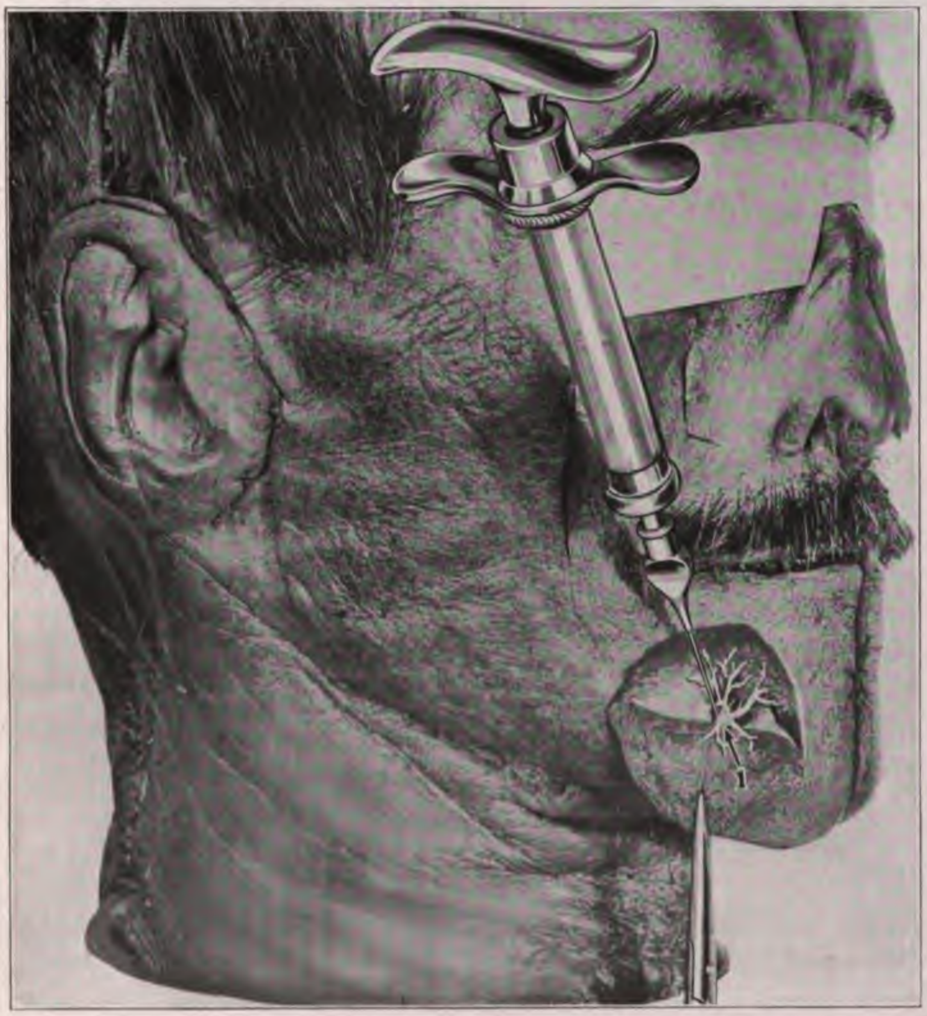


Fig. 443.—Anatomical specimen with depressed flap illustrating the needle in position at mental foramen by extraoral method.
1, Mental nerve.

needle in contact with the periosteum covering the external alveolar plate above the foramen.

Time to Wait for Anesthesia.—Wait two minutes for the preliminary injection to anesthetize the external tissues. The time to wait for anesthesia following the injection of the solution at the opening of the mental foramen and proper massaging of the tissues, is from three to five minutes, depending on the four factors enumerated on page 196.

Structures Anesthetized.—The structures anesthetized by injecting the solution at the mental foramen, following the extraoral method, are the same as those already enumerated on page 604 for the intraoral method, together with the skin and subcutaneous tissue. The blocking of the communicating or overlapping branches is the same as that given on page 606 for the intraoral method.

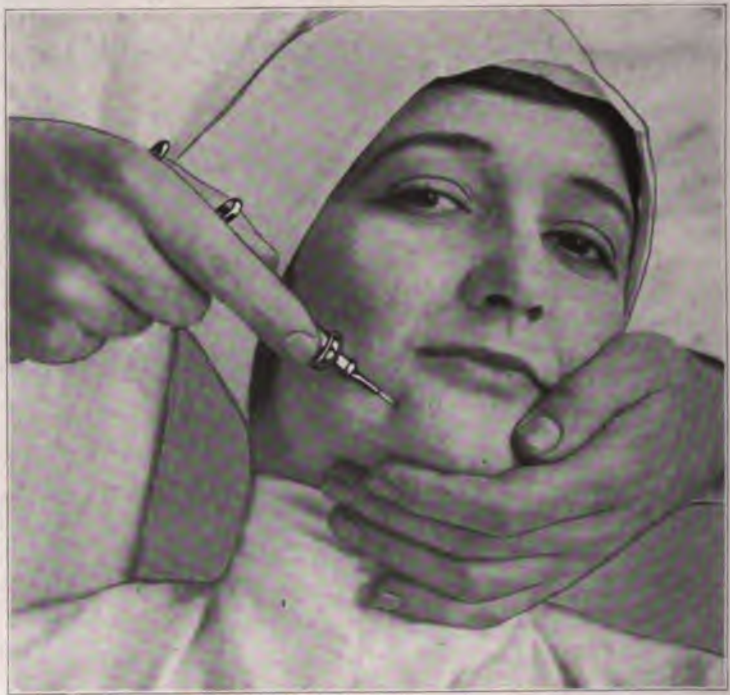


Fig. 444.—Needle in position while injecting the solution at mental foramen by extraoral method.

Indications for the Extraoral Method for Blocking the Mental Incisive Nerves.—This method is indicated if inflammation or infection is present in the tissues in the region of the lower bicuspid teeth. It is at this point that the needle is inserted for blocking the mental and incisive nerves at the mental foramen, by the intraoral method. Good results may be obtained by blocking these nerves by the extraoral method if the technic is properly executed.

BLOCKING THE INCISIVE NERVE BRANCHES

Topography of Anatomy.—The reader is referred to Chapter VII for a complete description of the incisive nerve. Only a synopsis will be given here. This branch continues anteriorly in the substance of the middle plate of bone of the lower jaw and is one of the terminal branches of the inferior dental, the other being the mental branch passing through the mental foramen. The incisive nerve gives off several small branches which supply the cuspid, lateral and central incisor teeth, alveolar process, a portion of the

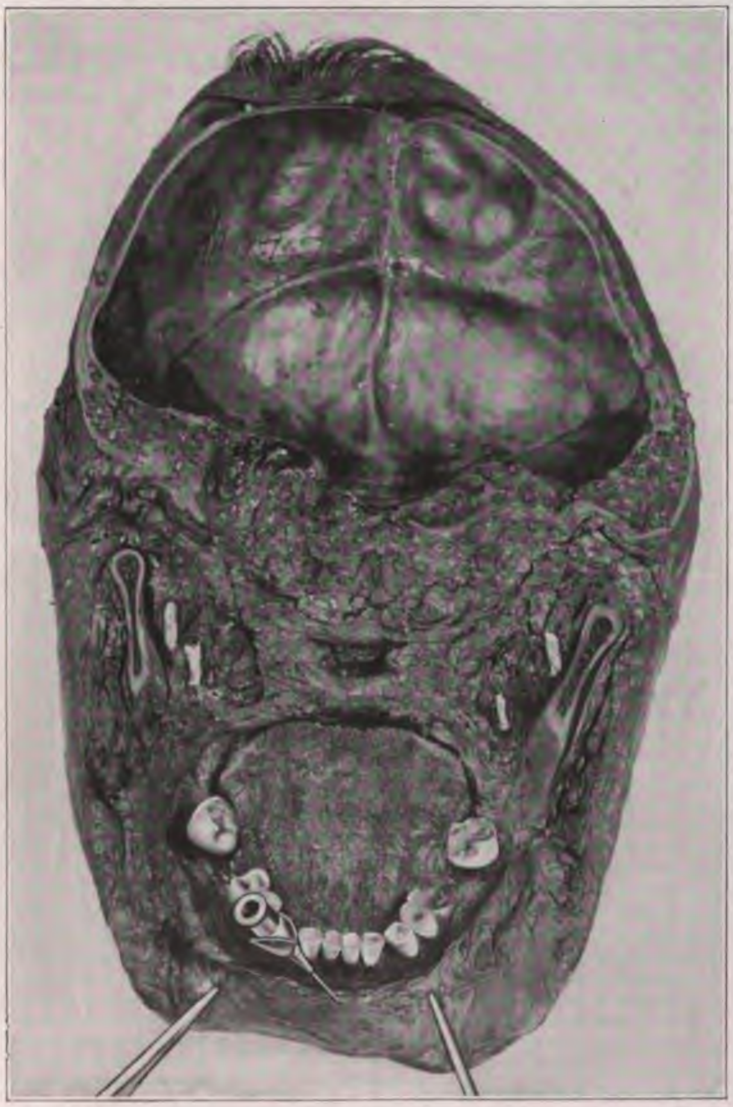


Fig. 445.—Wet specimen showing position of needle for blocking at left incisive fossa.

jaw bone and the labial periosteum, gum tissue and mucosa in the region of the above-named teeth. (See Figs. 60, 69 and 111.) The incisive nerve arising from the right inferior dental overlaps its fellow nerve from the opposite side across the median line. The interlacing or overlapping branches extend some distance on either side of the median line. For example, the incisive nerve branches on the right side of the jaw will cross the median line to the left side, and supply the tissues as far as the lateral incisor tooth. Therefore, in most cases the region occupied by the two centrals and laterals is supplied by both the right and left incisive nerves. These branches do not supply the lingual gum tissue, periosteum or mucosa.

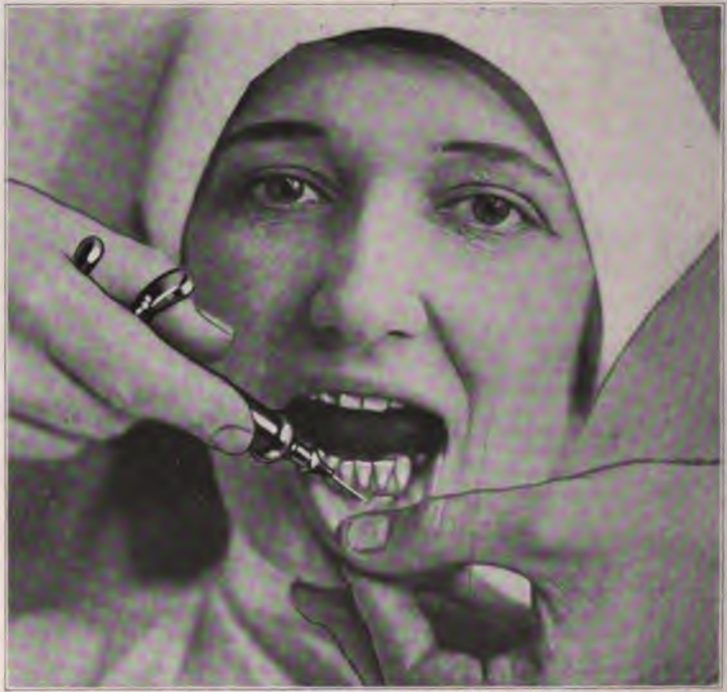


Fig. 446.—Illustrating the position of needle for injecting at the left incisive fossa.

Situated on either side of the median line are the incisive fossæ, located below and between the apices of the lateral and central incisor roots, and midway between the labio-gingival margins of the central and lateral and the lower border of the mandible. (See Figs. 32 and 102.) These fossæ are separated from each other by a bony prominence at the median line which is called the symphysis. (See Fig. 102.) The fossæ are concave, and in most cases several small foramina, known as the incisive foramina, are located in the bottom of each fossa, which transmit small nerves and blood vessels. The external plate of bone which forms the floor of the fossa, is in most cases very thin. If a fresh specimen is examined by stripping the periosteum, from one to six small foramina are seen which give direct communication from the exterior to the inner cancellous plate of bone. Examination of a dry mandible many times shows several foramina located in each of the incisive fossæ. However, with a dry specimen the foramina may be filled with debris, or become closed during the process of cleaning the skull. The small incisive foramina are of great importance in allowing the solution to pass readily through the external alveolar plate, thus reaching the incisive nerve branches.

Needle Employed.—The needle used for blocking the incisive nerve is No. 4, 25 gauge and 3 cm. in length. (See Fig. 177.)

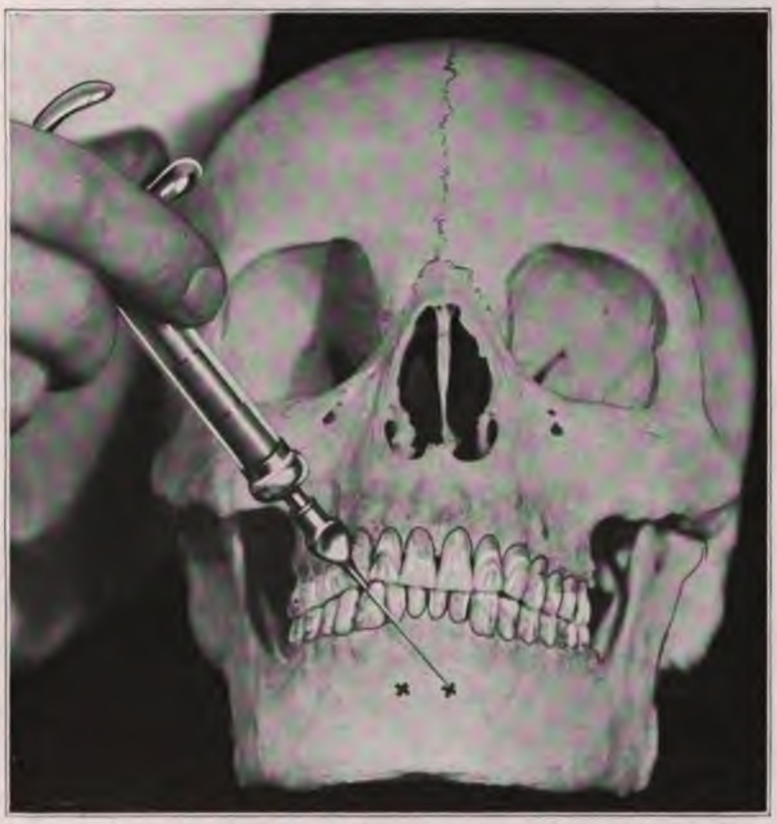


Fig. 447.—Incisive injection. X represents point of injecting solution at left incisive fossa. (See Fig. 450.)

Technic of Injection.—The incisive branch of the inferior dental is easily blocked if the operator understands the technic, osteology and nerve supply of the parts. The blocking of this nerve is of great advantage, not only for operative dentistry, but for the specialist in periodontia, as the region of the incisors and cuspid teeth is undoubtedly involved by pyorrhea in a greater number of cases than any other region. The technic of injection is as follows: In most cases the operation will involve the four incisor teeth, namely, the two centrals and two laterals, and only one insertion of the needle is necessary to block the nerve supply on the right and left sides of the median line (see Fig. 451). The chair is lowered with the patient in a semisupine position, and the operator standing behind the patient. The area is prepared by drying and applying the germicidal solution to the tissues which are to receive the needle; the syringe is held in the hand pen fashion, and the mucous membrane is punctured at the reflection between the lip and labial gum tissue. The initial puncture should always be made near the median line. (See Figs. 445 and 446.) The needle is advanced laterally, downward and

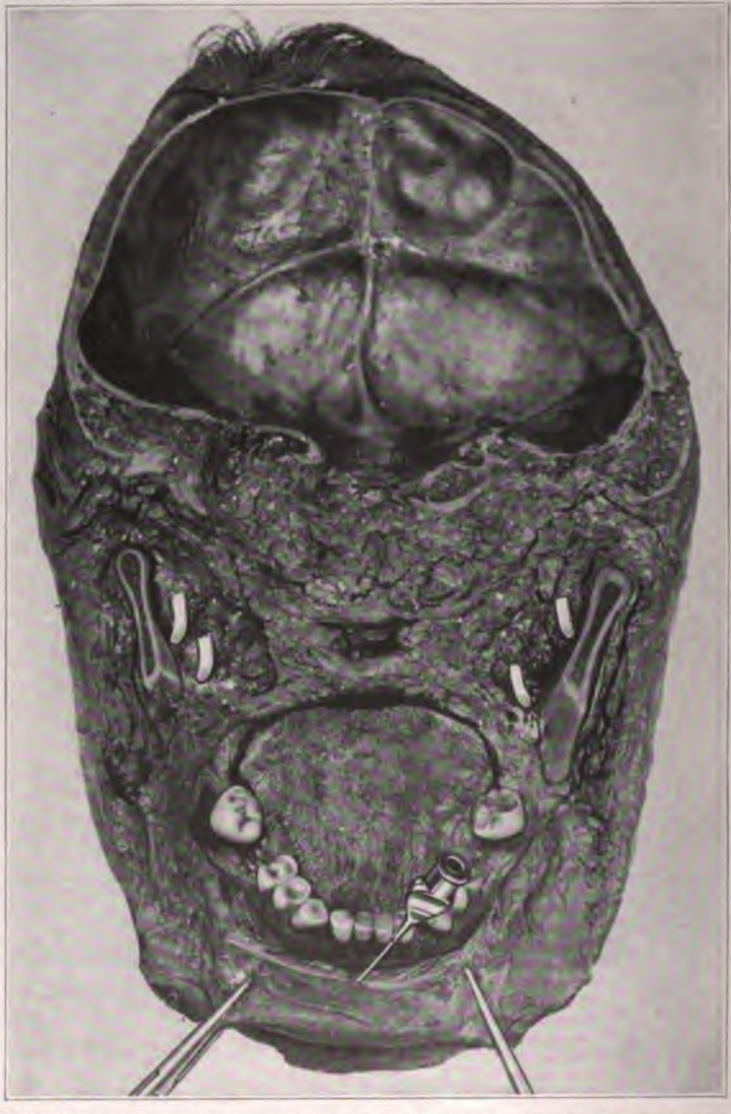


Fig. 448.—Wet specimen showing position of needle for blocking at right incisive fossa.

backward, directing it to the floor of the incisive fossa. The bevel of the needle should always be towards the bone. The needle should not be in contact with the periosteum, except at the time the incisive fossa is reached, at an approximate depth of one centimeter. (See Fig. 447.) One mil of solution is slowly injected; then the needle is withdrawn without taking it out of the tissue, and advanced toward the opposite fossa, using the reverse of the same technic (see Figs. 448, 449, 450). Only one puncture of the mucosa is necessary for the injection of 2 mils of solution in both the right and left fossæ (Fig. 451). While the needle is being advanced in the proper direction, it is of advantage to depress the lower lip of the patient with the thumb and index finger of the left hand. (See Figs. 446 and 449.) It is necessary to force the needle through the frenum located in the median line while reaching one of the fossæ, this depending upon the fossa injected first.

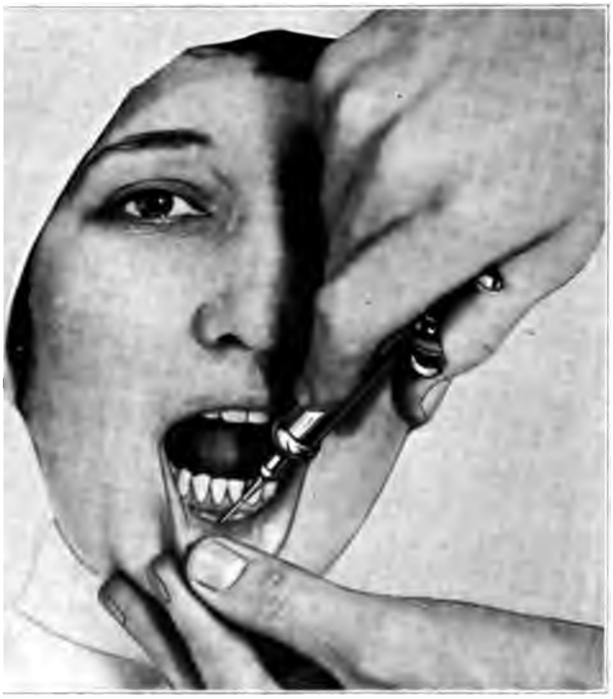


Fig. 449. Illustrating the position of needle for injecting at the right incisive fossa.

If the four lower incisor teeth are to be blocked, then apply the technic as given. If the central and lateral area on one side only is to be blocked, inject the solution in the incisive fossa on that side only.

Injection of Solution.--If the area occupied by the four lower incisor teeth is to be blocked, the syringe should contain two mils of the solution and deposit it equally in the right and left incisive fossæ. It is seldom necessary to inject the solution after the puncture is made and while the needle is being advanced in the direction of the incisive fossa, because little or no pain is experienced by the patient. However, if the patient should experience pain, then it is good practice to discharge a few minims of the solution as the needle is being advanced.

Precautions.—The operator should remember the prominence formed by the symphysis at the median line, and that the incisive fossæ are located below and beneath the apices of the lateral and central incisor teeth, midway between the labiogingival margin and the lower border of the mandible. Never insert the needle into the gum tissue and follow the periosteum to the fossa, as this procedure may result in the bending or breaking of the needle which will prevent it from reaching the floor of the fossa, and in addition unnecessary pain will be inflicted upon the patient by such a procedure. The needle should always be started in the mucosa between the lip and gum tissue at least 1 cm. from the gum tissue. (See Figs. 445, 446, 448, and 449.) The needle should form an acute angle with the external alveolar plate. The bevel of the needle should be towards the periosteum while the needle is being advanced into the tissues and as the solution is being injected. The direction of the needle should always be backward, downward and laterally to an approximate depth of 1 cm., leaving 2 cm. external to the tissue. If considerable pressure is required to discharge the solution from the syringe, withdraw it slightly or work the needle

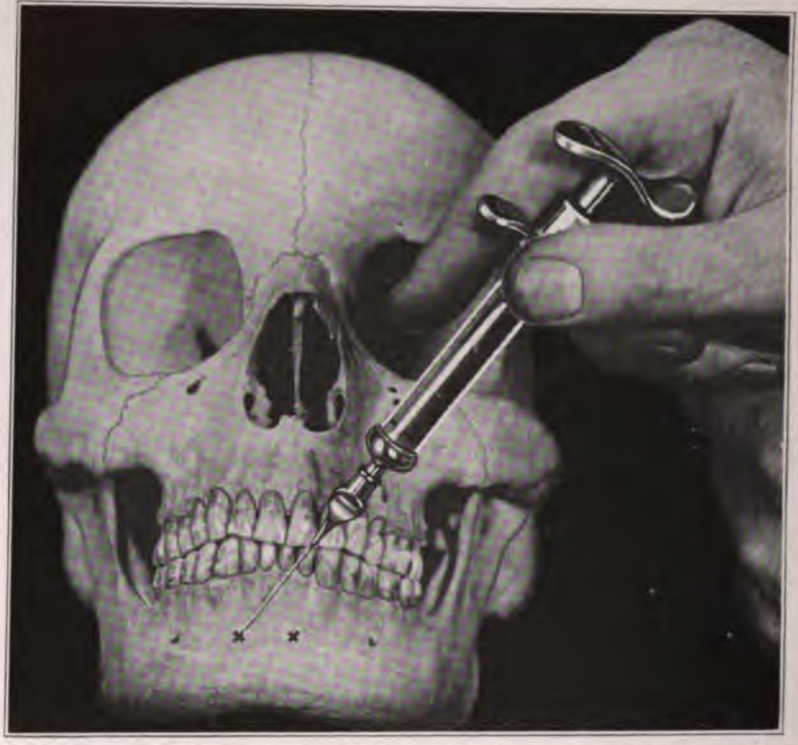


Fig. 450.—Incisive injection. X represents point of injecting solution at right incisive fossa. (See Fig. 447.)

back and forth 1 or 2 mm., which will greatly facilitate the discharging of the solution.

Time to Wait for Anesthesia.—If 1 mil of the solution has been injected in contact with the periosteum in the floor of each incisive fossa, anesthesia will be secured in the majority of cases in one minute. After the solution is injected either in the right or left fossa or in both of them, the skin over each fossa is massaged, using a circular motion, which materially hastens the rapid passage of the solution through the incisive foramina.

Structures Anesthetized.—If the incisive nerve branches are blocked by injecting the solution in only one fossa, anesthesia is secured in the central and lateral incisor teeth, alveolar process, a portion of the bone of the mandible, and the labial gum tissue, periosteum and mucosa in the immediate region of those teeth. If both incisive nerve branches are blocked by injecting the solution in the right and left fossæ, anesthesia will then be secured in the four lower incisor teeth, alveolar process, a portion of the bone of the lower jaw, labial periosteum, gum tissue and mucosa in the region of the four incisor teeth. (See Fig. 452.) In addition to the structures previously mentioned, a considerable portion of the lip is blocked. This injection alone is sufficient for dental operations upon the teeth, such as cavity preparation, pulp removal, or shaping the crowns of the teeth for bridge abutments, or for the performance of any operation which involves the soft structures located on the labial side of the four lower incisors. If these teeth are to be extracted, pus pockets curetted, or any other operation which involves the lingual gum tissue, periosteum and mucosa, is to be performed, then it is necessary to block the nerve supply on the lingual side. The technic for this lingual

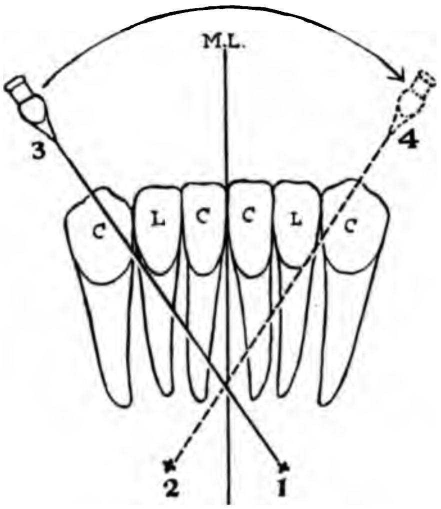


Fig. 451.—Diagram illustrating the plane through which the needle passes for blocking the incisive nerves at the right and left incisive fossæ.

1 and 2, Incisive fossæ. Note how the needle indicated by 3 is passed across median line in direction of arrow to position indicated by 4.

blocking is given on page 623. The nerve supply on the lingual side should not be blocked with that of the incisive blocking unless the operation involves the lingual tissues.

Blocking to Include Lower Cuspid with Central and Lateral.—In some cases it will be found that partial anesthesia will be produced in the lower cuspid tooth following an incisive injection, and when this is the case it signifies that a great deal of the solution has penetrated the external alveolar plate and passed backward in the middle cancellous bone, thereby reaching the nerve supply in the cuspid region. However, the inferior dental nerve located distally to the cuspid tooth is only partially blocked, and if it is desired to include the cuspid in the area of anesthesia, it becomes necessary to make an injection at the mental foramen. (See Fig. 453.)

Blocking the Interlacing or Overlapping Branches.—The blocking of the communicating branches for this region is a very simple procedure. If the tissues are to be operated at the median line, then make the right and left incisive injections. If the operation involves the cuspid tooth, block the inferior dental branch by making the injection at the mental foramen.

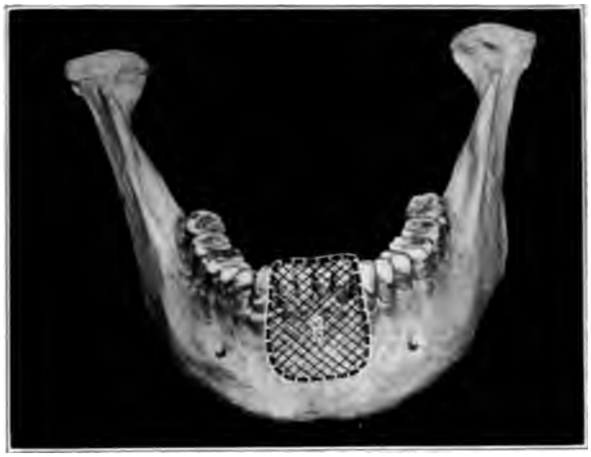


Fig. 452.—1 indicates the area of anesthesia produced by blocking the right and left incisive nerves at the incisive fossæ.

Unilateral Blocking to Median Line.—If the operation involves all or part of the teeth on one side of the lower jaw up to the median line, then the inferior dento-lingual injection is made, and in addition the incisive injection on the opposite side. If the teeth are to be extracted, block the lingual nerve supply lingual to the central and lateral incisor teeth. (For technic, see page 623.) If only dental operations are to be performed on the teeth, or the buccal or labial structures are involved, it is only necessary to block the inferior dental and incisive nerves.

Contraindications for Blocking the Incisive Nerve Branches in the Incisive Fossa.—This injection is contraindicated in case inflammation or infection is present in the labial structures, in the region of the median line; and instead block the area by making right and left mental injections.

BLOCKING THE LINGUAL NERVE SUPPLY IN THE REGION OF THE TWO LOWER BICUSPID TEETH

Topography of Anatomy.—The reader should review the anatomy of the lingual nerve and the tissues it supplies with sensation, described in Chapter VII. Figs. 94, 97, 99, 100, and 101 show the lingual nerve and how it passes anteriorly along the lingual gum tissue, in the floor of the mouth and to the anterior two-thirds of the tongue. The periosteum, gum tissue, and mucous membrane located in the region of the bicuspid teeth are supplied by branches from the lingual nerve. These must be blocked in addition to the mental and incisive nerves, if extraction of the bicuspid teeth is desired, or if the lingual tissues are involved in the operation.

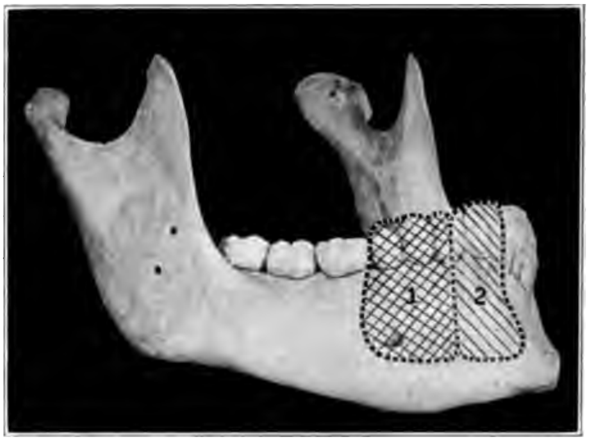


Fig. 453.—Illustrating area of anesthesia produced by combined mental and incisive block injections. 1, Mental injection; 2, incisive injection.

Needle Employed.—The needle used for this injection is No. 4, 25 gauge, and 3 cm. in length.

Technic of Injection.—The syringe is held pen fashion, and the barrel placed across the mouth in the region of the cuspid and first bicuspid teeth (see Fig. 454). The lingual tissues in the region of the bicuspid teeth are prepared for the reception of the needle. It is good practice to insert a large piece of gauze along the side of the tongue, which assists in maintaining a dry field after the germicidal solution has been applied. The puncture is made in the lingual tissue midway between the linguo-gingival margin and the position occupied by the apex of the lower first bicuspid tooth (see Figs. 455 and 456). The needle is forced backward and laterally until it reaches the periosteum, then the syringe is extended across the median line until the needle is parallel to the surface of the linguo-alveolar plate. Four minims of the solution are injected as the needle penetrates the tissue (see Figs. 457 and 458). The needle is advanced downward and backward, injecting four minims as the needle advances in the tissue in contact with the periosteum covering the lingual alveolar plate until the point is located below and distal to the apex of the lower second bicuspid tooth (see Fig. 459). In most cases the needle is inserted into the tissue to a depth of 1 cm. As soon as this location is reached, inject one-half mil of the solution.

Injection of Solution.—As already stated, it is good practice to inject the solution continuously from the puncture point until the needle is inserted the proper depth into the tissue, especially if the patient experiences the slightest pain. In most cases the needle may be advanced to the desired depth without any resistance by the patient. The syringe should contain 1 mil of the solution, so that after the 4 minims are injected at the starting point and 4 minims as the needle advances into the tissue, ½ mil will remain for the final injection into the region of the lingual nerve branches. After a few minims of the solution have been discharged, the operator will notice an expansion of the tissues due to infiltration, which will soon disappear.

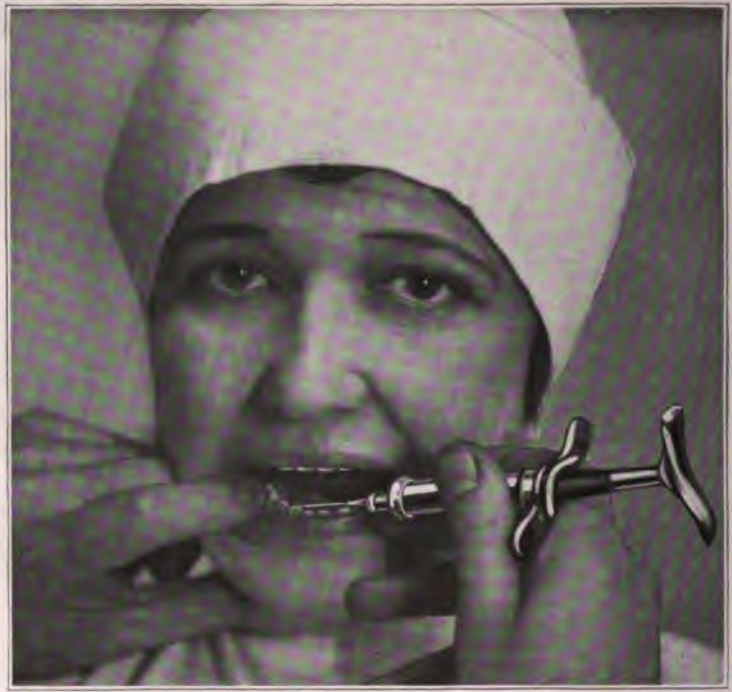


Fig. 454.—Showing position of syringe while starting needle for blocking branches of lingual nerve in bicuspid region. (See Fig. 456.)

Precautions.—The first position of the syringe, as shown in Fig. 454 should be assumed so that the puncture of the tissue can be made midway between the linguo-gingival margin and the apex of the lower first bicuspid tooth. The object of holding the syringe across the median line is to facilitate the insertion of the needle into the tissue at that point. Caution should be exercised in observing that the needle is forced downward and backward, bevel towards and in contact with the periosteum, and parallel to the linguo-alveolar plate. Always make sure that one-half mil of the solution is injected to the distal of the apex of the lower second bicuspid tooth, in order to block the lingual nerve branches before they reach the lingual surface of the bicuspid teeth. The object of injecting at this point is to block the nerve supply before it reaches the operative area, and if the solution is not injected distal to this area, anesthesia will not be secured. The solution should be injected very slowly to avoid rapid distention of the tissues which may cause postoperative discomfort and pain.

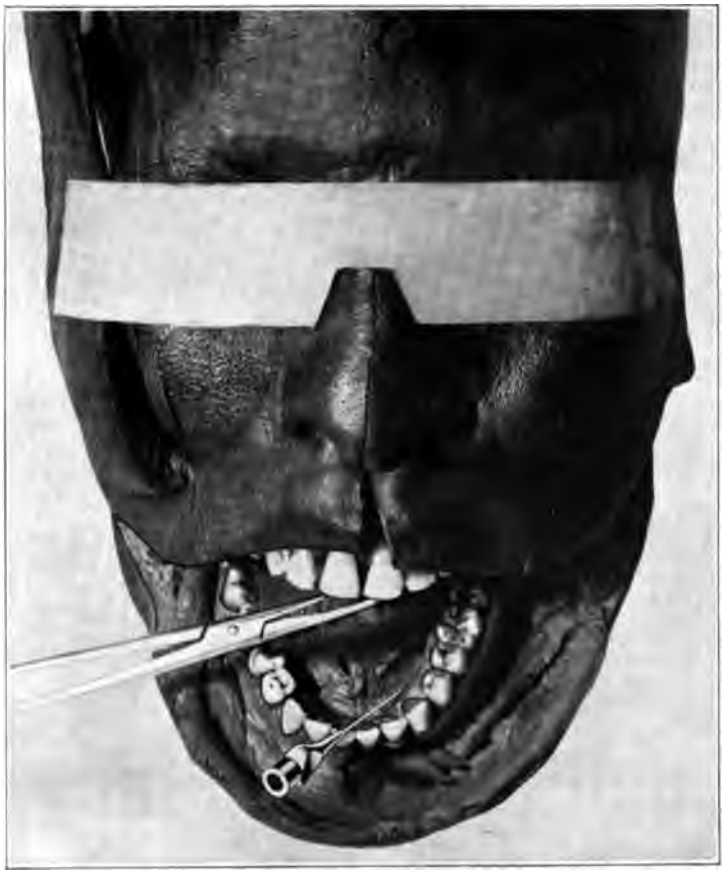


Fig. 455. - Wet anatomical specimen showing position of needle at starting point for blocking branches of lingual nerve in bicuspid region.

Time to Wait for Anesthesia.—If the solution is properly injected, deep anesthesia will be secured within one minute.

Structures Anesthetized.—The tissues anesthetized by this injection are the lingual gum tissue and periosteum covering the linguo-alveolar plate over the bicuspid teeth, and the mucosa in the immediate region.

Blocking the Interlacing or Overlapping Branches.—If only the lower first and second biscuspid region is involved, the blocking of the lingual branches, as above outlined, is all that is necessary. However, if the operation extends anterior to the lower bicuspids, it will be necessary to block the lingual branches which cross the median line from the opposite side. This is done by anesthetizing the lingual nerve supply in the region of the lower cuspid, lateral and central incisor teeth. The syringe is held across the mouth on the opposite side of injection. The puncture point is located midway between the linguo-gingival margin and the apex of the central incisor tooth, and the needle is forced laterally, backward and downward along the periosteum covering the linguo-alveolar plate, until the point of the needle is in the region of the apex of the lateral incisor tooth. At this point ½ mil of the solution is injected.

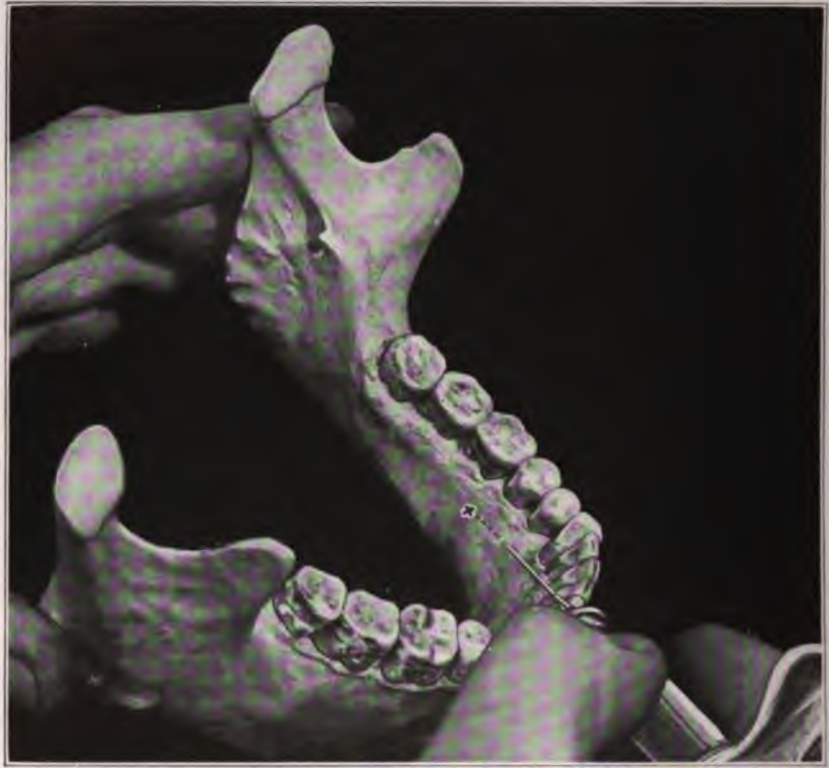


Fig. 456.—Showing starting point of needle for blocking branches of lingual nerve in bicuspid region. X represents point of injection of solution.

BLOCKING THE LINGUAL NERVE BRANCHES SITUATED TO THE LINGUAL OF THE FOUR LOWER INCISOR TEETH

Topography of Anatomy.—The periosteum, gum tissue and mucosa to the lingual of the central, lateral and cuspid teeth are supplied by the lingual nerve. (See Fig. 99.) The osteology of the linguo-alveolar plate in this region should be carefully studied. The lingual plate is convex, and this fact should not be forgotten while the technic is being carried out. (See Figs. 103 to 108.)

Needle Employed.—Needle No. 4, 25 gauge, and 3 cm. in length, is used for blocking the lingual nerve supply in this region.

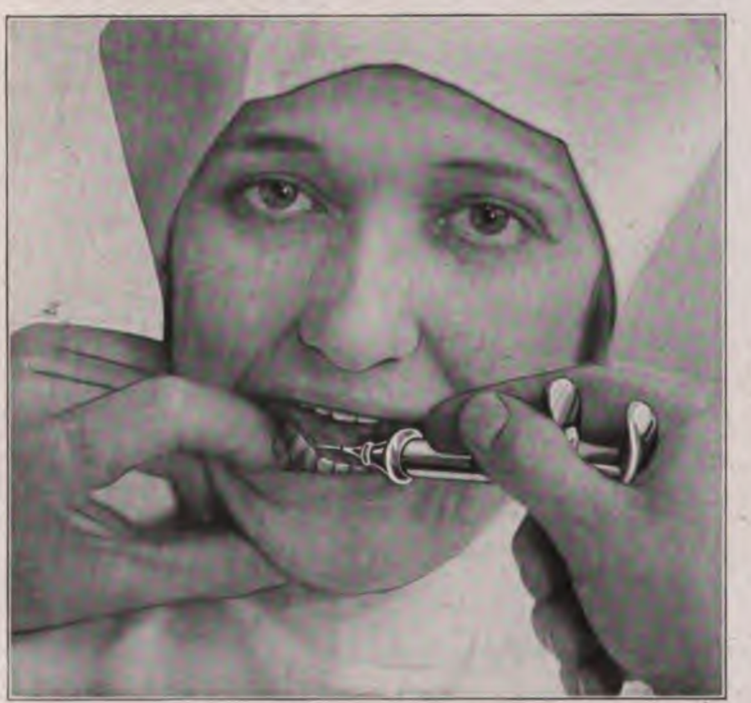


Fig. 457.—Illustrating position of syringe while discharging solution for blocking the branches of lingual nerve in bicuspid region. (See Fig. 459.)

Technic of Injection.—The blocking of the lingual nerve at this point generally accompanies the "incisive injection" on the labial side. On the lingual side it is not possible to make one puncture in the median line and to inject the solution, say on the left side, then withdraw the needle and bring syringe to opposite side and repeat the technic, as on the labial for making the two incisive injections. The reason this can not be done is that the anatomical shape of the lower jaw will not permit it. Also in many cases the incisor teeth are lingually inclined, which makes it difficult to insert a needle in the region of the median line. The linguo-alveolar plate being convex superior-inferiorly and concave laterally, contraindicates such a movement of the syringe; therefore two separate injections must be made for blocking the nerve supply to the lingual of the central and lateral incisors.

Let us take the following example: Suppose the labial incisive injections have been made which anesthetizes the incisor teeth, alveolar process, and labial structures. It is desired to extract the four lower incisors, which makes it necessary to block the lingual nerve supply.

The technic is as follows: The chair is lowered, the patient placed in a semisupine position, the operator standing behind the chair. The mucous membrane and gum tissue posterior to the incisor region are carefully dried and the germicidal solution applied over an area 2 cm. in diameter. The syringe is held across the mouth pen fashion as is illustrated in Figs. 460 and 461. The initial puncture is made midway between the linguo-gingival margin and the apex of the central incisor. (See Figs. 461 and 462.) When the point of the needle enters the tissue, four minims of the solution are injected; advance the needle until the bevel reaches the periosteum, and inject four minims, then the

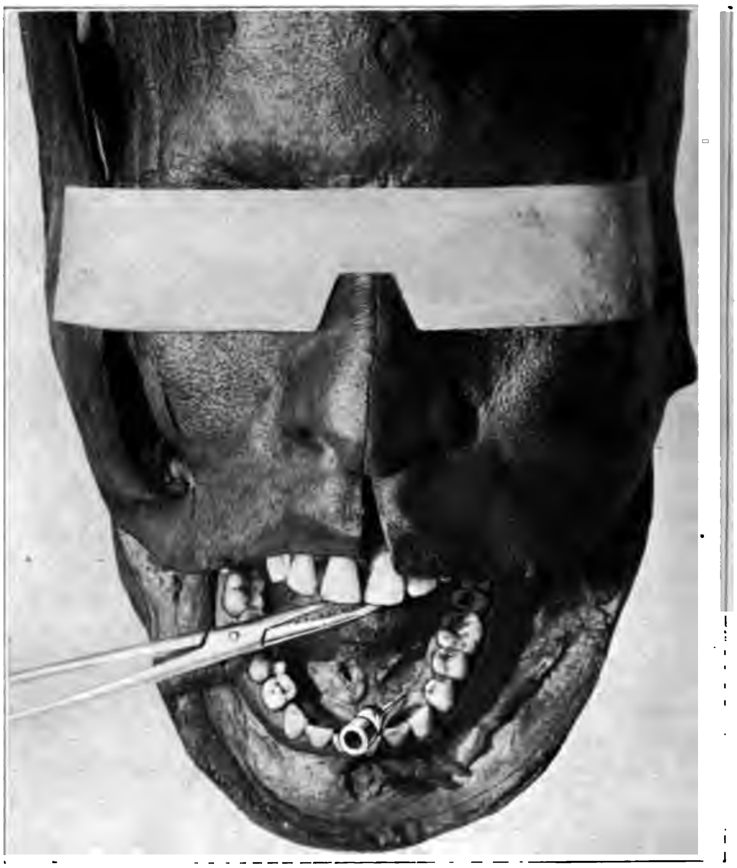


Fig. 458.—Wet specimen showing position of needle while discharging the solution for blocking the branches of lingual nerve in bicuspid region.

needle is advanced downward, laterally and anteriorly with bevel in contact with the periosteum covering the linguo-alveolar plate, until it reaches the area below and lateral to the apex of the lateral incisor, at which point one-half mil of the solution is slowly injected. (See Figs. 463 and 464.) At least fifteen seconds should elapse after each of the injections while the needle is being inserted. The needle should be advanced slowly until the proper depth is reached, which is 1 cm. in most cases. The total quantity of solution injected is one mil. The average depth of the needle is 1 cm., and the needle employed is 3 cm. in length; therefore, 2 cm. will remain exterior to the puncture point. This injection suffices for tissues to the lingual of the central and lateral incisor teeth on one side only. Remove the needle and repeat the injection on the opposite side, using identically the same technic as described. (See Figs. 465, 466, 467, and 468.)

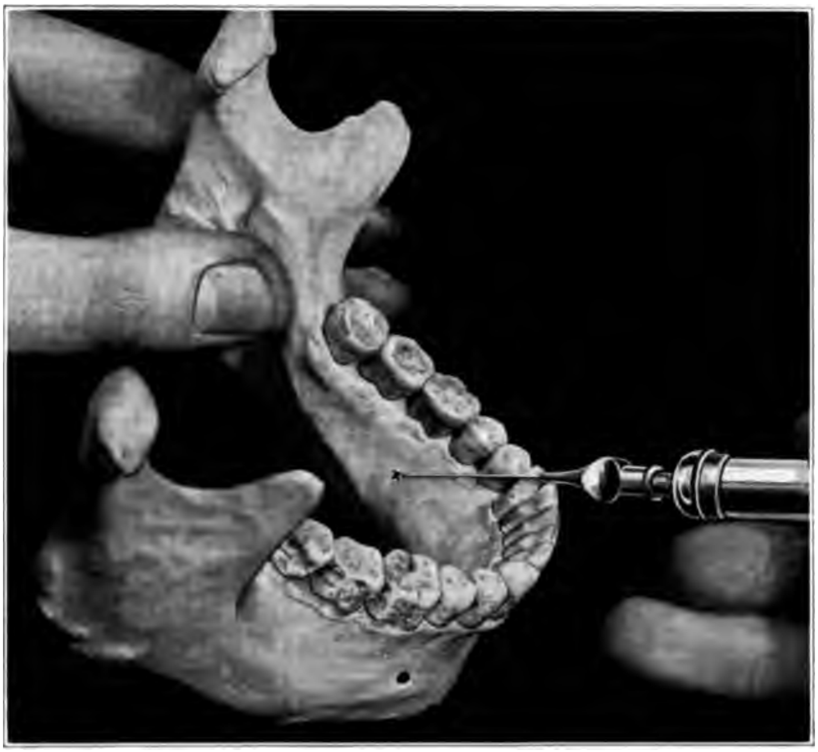


Fig. 459.—Illustrating position of needle while blocking lingual nerve branches in bicuspid region. X represents point of injection.

Injection of Solution.—This part of the technic has been covered, but it is well to emphasize the fact that four minims of the solution should be injected into the lingual gum tissue at the puncture point, which is midway between the linguo-gingival margin and apex of the lateral incisor. The needle is advanced in the direction, as given, until the periosteum is reached

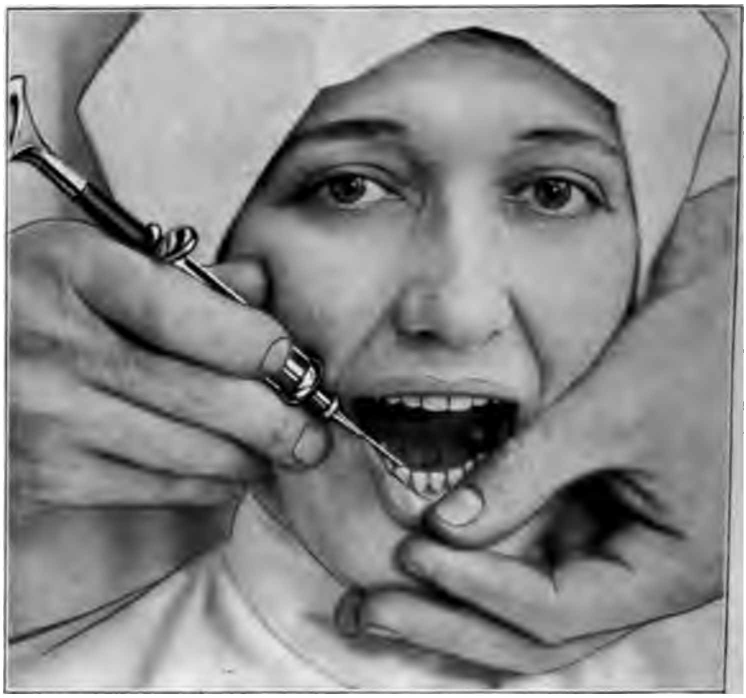


Fig. 460.—Illustrating position of syringe and needle at starting point, lingual to left central for blocking lingual nerve branches below and distal to apex of left lateral.

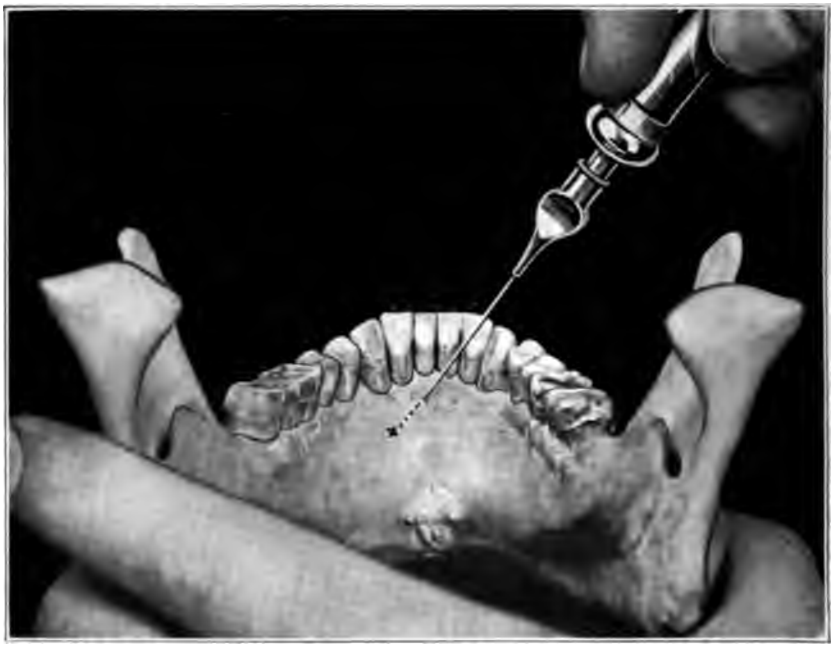


Fig. 461.—Showing starting point of needle for blocking branches of lingual nerve distal and below apex of left lateral incisor. X represents area of injection.

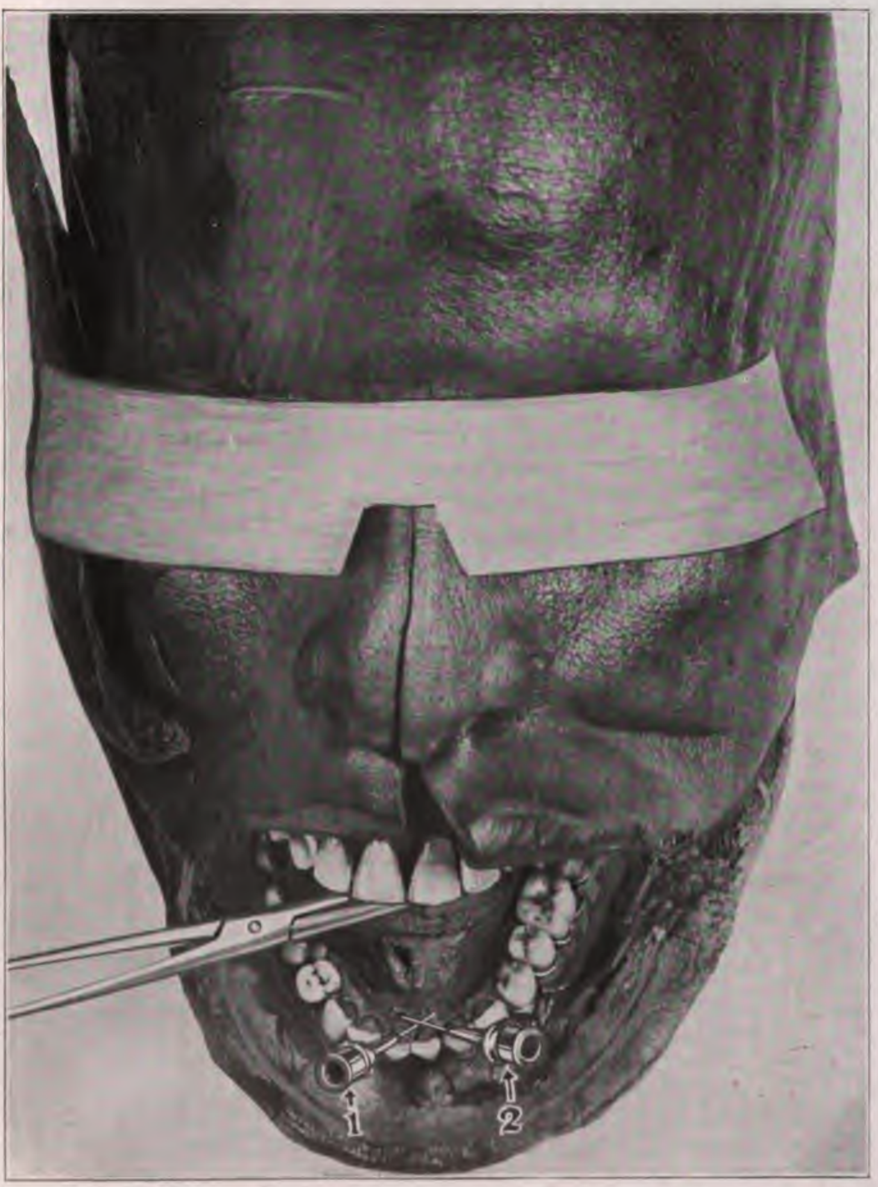


Fig. 462.—1, Needle in position for producing lingual anesthesia of the lower left incisors; 2, needle in position for producing lingual anesthesia of the lower right incisors.

and four minims more injected. When the area is reached distal to, and below the apex of the lateral incisor, one-half mil of the solution is slowly injected. The presence of the solution at this point will cause distention of the tissues, which will readily subside as diffusion takes place.

Precautions.—The needle should never be forced through the gum tissue to the periosteum without first injecting four minims; then carefully advance the needle until the periosteum is reached, and again inject four minims, as such a procedure will eliminate all pain incident to inserting the needle, as above directed. At the time the needle is inserted the placing of the index finger behind the needle will greatly aid the operator in inserting or starting it into the tissue, as in some cases it is somewhat difficult to make the initial puncture, especially if the teeth are lingually inclined. By holding the syringe across the arch, to the side opposite the injection, the operator will be aided considerably in carrying out the technic. (See Fig. 460.)

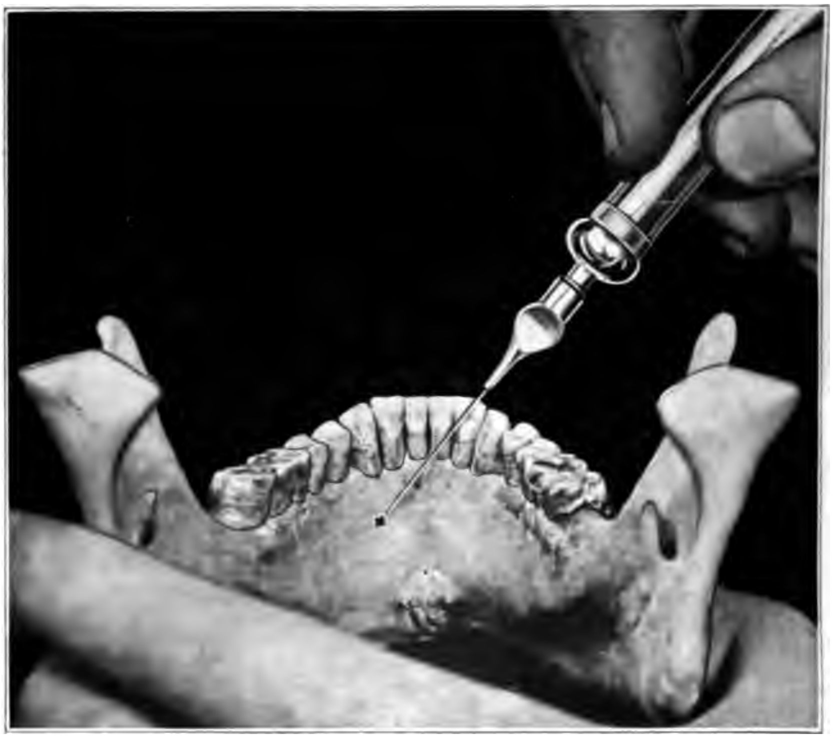


Fig. 463.—Position of needle while discharging the solution for blocking branches of lingual nerve below and distal to apex of left lateral incisor. X represents area of injection.

Time to Wait for Anesthesia.—Anesthesia is secured in most cases in less than one minute.

Structures Anesthetized.—If the lingual nerve supply is blocked in this region on both the right and left sides, anesthesia will be produced in the lingual periosteum and gum tissue covering the linguo-alveolar plate, and also considerable mucous membrane located in the anterior portion of the floor of the mouth. Anesthesia of the linguo-alveolar plate will not be secured, as this structure is supplied by the incisive nerve branches from the inferior dental and are blocked by the incisive injection. (See Fig. 469.)

Blocking the Interlacing or Overlapping Branches.—The blocking of the lingual nerve branches in this region is resorted to in conjunction with the blocking of the inferior dento-lingual nerve at a point 1 cm. above the occlusal plane of the lower teeth, if the operation extends to the median line. For example, suppose it is desired to remove all of the teeth on one side of the lower jaw to the median line, the injections made are the inferior dento-lingual, incisive on the opposite side of the median line from that of the inferior dento-lingual injection, and in addition the nerve supply lingual to the central and lateral incisor teeth is blocked, using the technic given. The last mentioned injection will block the lingual nerve branches which overlap at the median line from the opposite side.

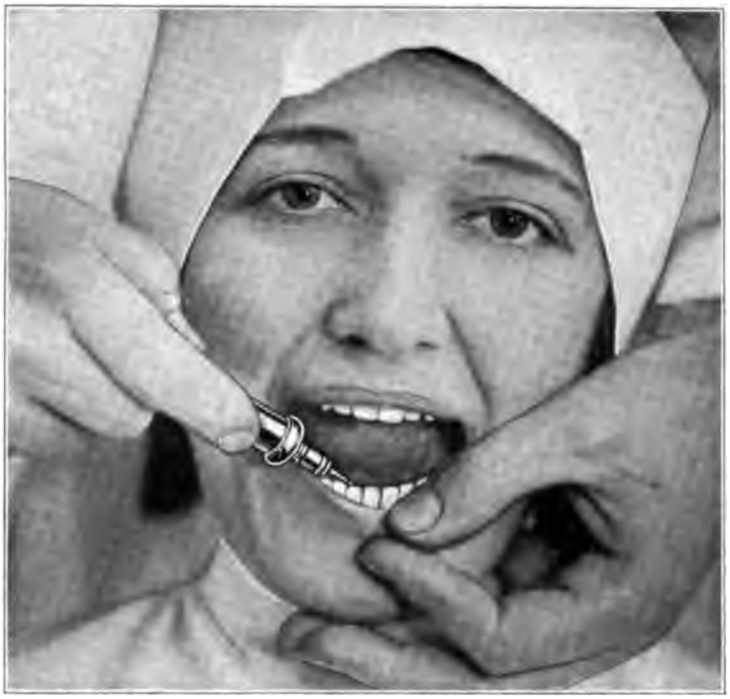


Fig. 464.—Position of needle and syringe while injecting the solution below and distal to apex of left lateral for blocking lingual nerve branches.

BLOCKING THE TEN LOWER ANTERIOR TEETH FOR DENTAL OPERATIONS NOT INVOLVING THE LINGUAL STRUCTURES

The blocking of the ten lower anterior teeth, that is, from the second bicuspid on the left side to the second bicuspid on the right side, for such operations as cavity preparation, pulp removal, shaping the crowns of teeth for bridge abutments, or for any other operation which involves the labial and buccal tissues, is accomplished by making a right and left mental injection. (See technic on page 592.)

BLOCKING THE TEN LOWER ANTERIOR TEETH FOR EXODONTIA OR OTHER SURGICAL OPERATIONS WHICH INVOLVE THE LINGUAL STRUCTURES

The block injections made to anesthetize this area so that surgical operations can be performed, are the right and left mental injections (see technic

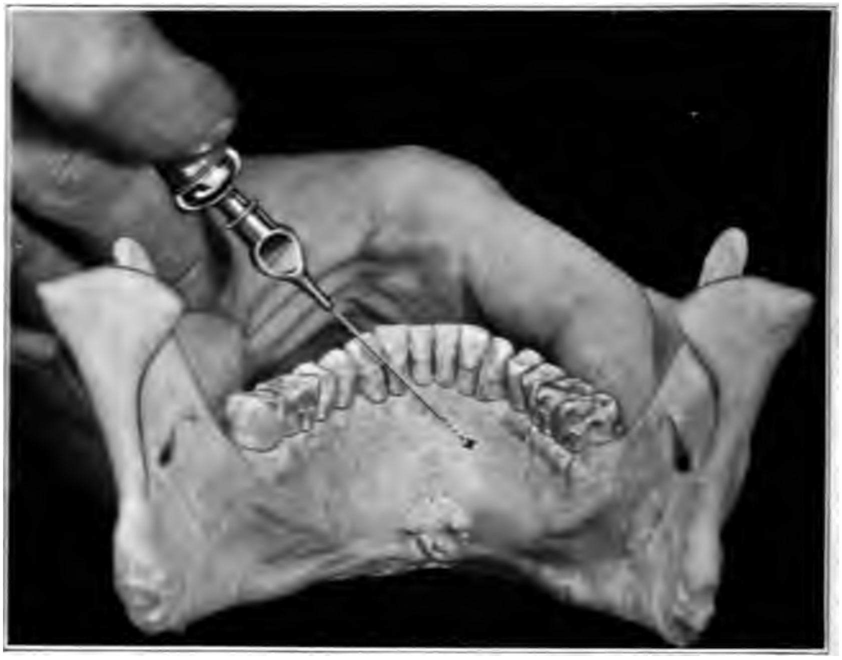


Fig. 465. Starting [illegible] distal and below apex of right [illegible]

page 592), and in addition the nerve supply on the lingual side is blocked by injecting the solution to the lingual and distal to the apex of the lower second bicuspid tooth. (For technic, see page 619.) This same area can be blocked by the inferior dento-lingual injection on the right and left sides at a point 1 cm. above the occlusal plane of the lower teeth, but when the nerve branches are blocked at that point, anesthesia is not only secured in the region of the ten lower anterior teeth, but in addition, the three molars and other tissues on each side. Therefore, it is advisable to use the mental and lingual injections, as given, and restrict the anesthesia to the area of operation.

BLOCKING THE LOWER CENTRAL, LATERAL, CUSPID, FIRST AND SECOND BICUSPID TEETH FOR DENTAL OPERATIONS NOT INVOLVING THE LINGUAL STRUCTURES

In case the five named teeth, or any number of them, are to be blocked for dental operations, the mental injection is made on the same side of operation (see technic, page 592), together with the incisive injection on the opposite side. (See technic, page 611.) These two injections will block the five teeth, alveolar process and labial structures, and will suffice for such operations as pulp removal, cavity preparation, and other operative procedures on teeth and labial structures.

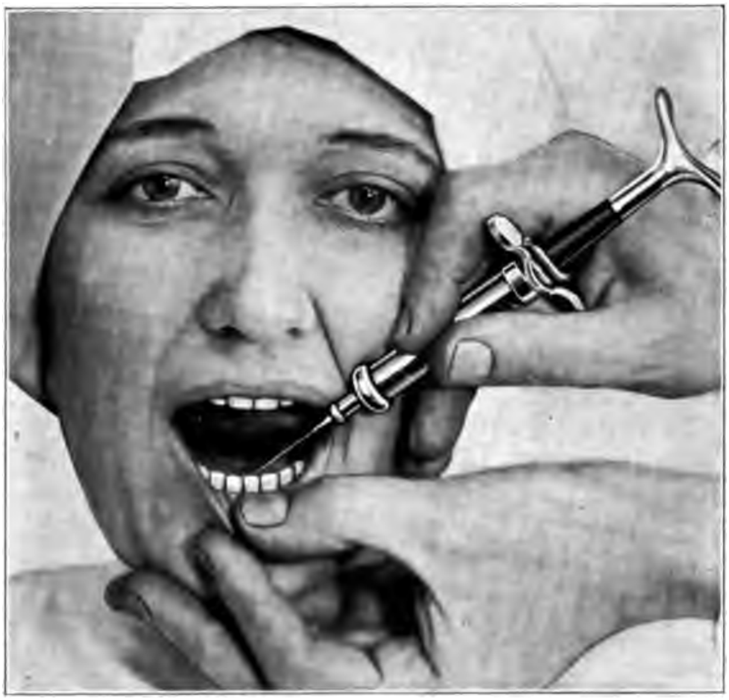


Fig. 466.—Position of syringe and needle at starting point, lingual to right central for blocking lingual nerve branches below and distal to apex of right lateral.

BLOCKING THE LOWER CENTRAL, LATERAL, CUSPID, FIRST AND SECOND BICUSPID TEETH FOR EXODONTIA OR OTHER SURGICAL OPERATIONS, INCLUDING THE LINGUAL STRUCTURES

Make the mental injection on the side of operation (see technic, page 592), and in addition the incisive injection on the opposite side (see technic, page 611). Block the lingual nerve supply with two injections. In the first lingual injection the solution is deposited to the distal of the apex of the lower second bicuspid. (See technic, page 619.) The second lingual injection is to the lingual and distal to apex of the central incisor on opposite side. (See technic, page 623.)

BLOCKING THE LOWER CUSPID TOOTH FOR OPERATIVE DENTISTRY

Many operators have experienced considerable difficulty in anesthetizing the lower cuspid tooth. However, no difficulty should be experienced if the proper injections are made. If a large gingival cavity is to be prepared in the lower cuspid or a pulp is to be removed, make the mental and incisive injections. (See technic, pages 592 and 611.)

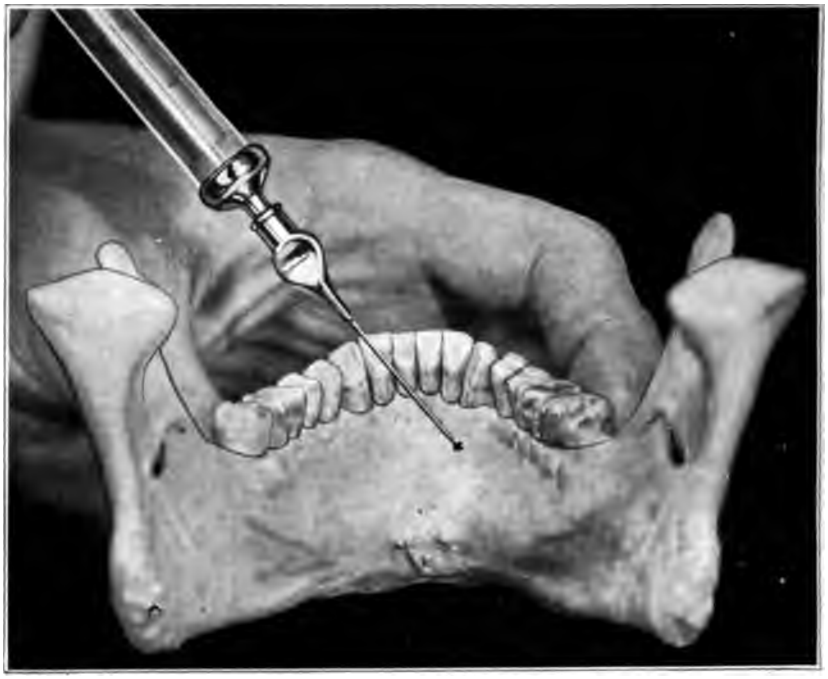


Fig. 467.—Position of needle while discharging the solution for blocking branches of lingual nerve below and distal to apex of right lateral incisor. X represents area of injection.

BLOCKING THE LOWER CUSPID FOR EXODONTIA OR SURGERY

If the cuspid tooth is to be extracted or the lingual tissues are involved, in addition to blocking by the mental injection and the incisive injection, the lingual nerve supply is blocked by inserting the needle midway between the linguo-gingival margin and the apex of the cuspid tooth, holding the barrel of the syringe across the mouth on the opposite side, and injecting four minims. After waiting fifteen seconds the needle is advanced until the bevel reaches the periosteum, and four minims more of solution are injected. The needle is now advanced downward, laterally and slightly backward to an approximate depth of 1 cm. or until an area is reached which is distal to the apex of the cuspid, at which point one-half mil of the solution is injected.

BLOCKING THE LOWER TEETH ACROSS THE MEDIAN LINE, INCLUDING ALL TEETH, BUCCAL AND LINGUAL TISSUES FROM THE LOWER THIRD MOLAR TO THE LOWER SECOND BICUSPID ON OPPOSITE SIDE

It is not necessary to make two inferior dento-lingual injections to block the area extending from the lower third molar to and including the second bicuspid on the opposite side. This area is blocked by making an inferior dento-lingual injection and a mental injection on the opposite side. In addition the lingual nerve supply is blocked (see technic, page 623) on the same side of the mental injection by depositing the solution to the lingual of and distal to the apex of the lower second bicuspid tooth. In approximately 75 per cent of cases the long buccal nerve must be blocked.

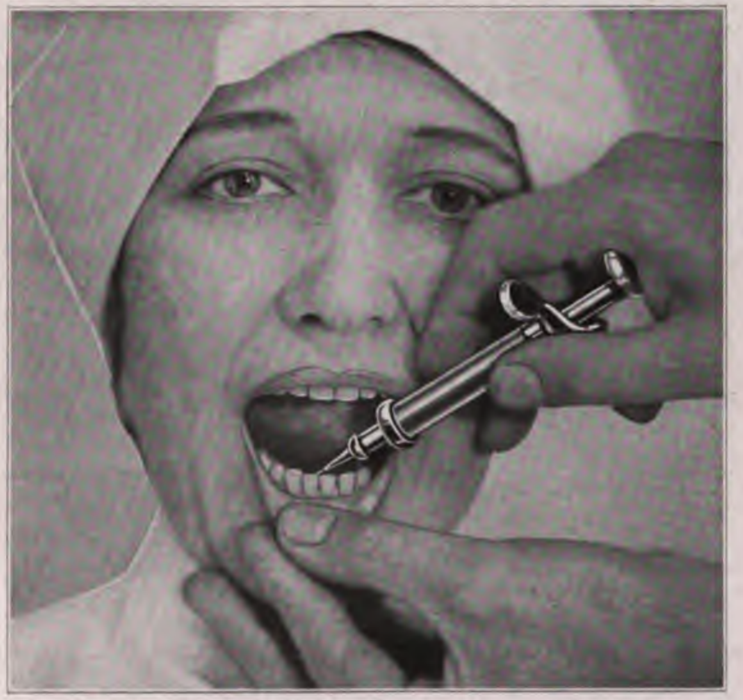


Fig. 468.—Position of needle and syringe while injecting the solution below and distal to apex of right lateral for blocking lingual nerve branches.

BLOCKING THE LOWER SIXTEEN TEETH, ALVEOLAR PROCESS, A PORTION OF THE LOWER JAW, BUCCAL, LABIAL AND LINGUAL TISSUES

In case the lower jaw is to be blocked, as for removing all of the lower teeth, the right and left inferior dento-lingual injections are made at a point 1 cm. above the occlusal plane of the lower teeth. In approximately 75 per cent of the cases the long buccal injections are necessary. It has been found that in a very small percentage of cases, the blocking of the inferior dento-lingual nerves on both sides will not produce deep anesthesia of the labial gum tissue, periosteum and mucosa in region of median line. The reason for this is that in a small percentage of cases the labial region of the lower central, lateral and cuspid teeth is supplied by branches from the cervical plexus, in addition to the branches of the inferior dental nerve. If the operator experiences such a condition and finds that deep anesthesia has been secured on both sides of the lower jaw distal to the cuspid region, it is apparent that the sensation is not from the inferior dental, but is derived from the cervical plexus. This nerve supply is easily blocked by injecting the solution into the right and left incisive fossæ.

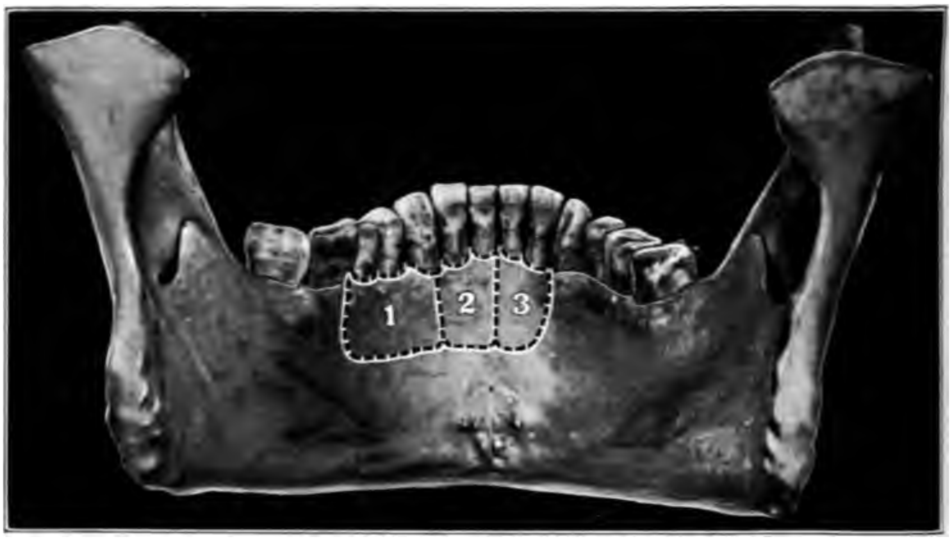


Fig. 469. - Illustrating areas of anesthesia by blocking lingual nerve branches.

1, Area of anesthesia produced by injecting solution lingual to bicuspids. (Usually accompanies mental block injection.) 2 and 3 represent areas of anesthesia produced by injecting solution below and distal to apices of right and left lateral incisors. (Usually accompanies incisive block injection.)

CHAPTER XXVII

INSUFFLATION, INTRAVENOUS, INTRAARTERIAL AND SPINAL METHODS OF PRODUCING LOCAL ANESTHESIA

THE INSUFFLATION METHOD OF PRODUCING ANESTHESIA OF THE ANTERIOR SUPERIOR DENTAL (ALVEOLAR) NERVE

Immediately following the discovery of cocain in 1884, Dr. Petsch anesthetized the area supplied by the anterior superior dental nerve by applying a tampon saturated with the anesthetic solution in the anterior inferior portion of the nasal cavity. In 1908 De Terra described a very simple technic for anesthetizing the region occupied by the central, lateral and cuspid teeth. If the teeth are to be anesthetized on the right side, the tampon is placed in the right nostril and vice versa if the left side is to be blocked. The chair is lowered, and the patient placed in an upright position, with the operator standing or sitting in front. A nasal speculum is used to dilate the nostril, exposing the anterior portion of the inferior meatus, and the anterior portion of the nasal septum. De Terra's technic is to employ an absorbent tampon which is attached to a probe. This tampon is saturated with a 5 per cent cocain-adrenalin solution, and then applied by massaging the tissues in the anterior inferior portion of the nasal cavity in the region of the nasal septum and inferior meatus. The patient soon experiences a sensation of numbness, which is accompanied by lachrymation and is quickly followed by anesthesia of the mucous membrane. Following this, a small tampon of cotton, about the size of the end of the index finger, attached to a string, is saturated with the anesthetizing solution, and packed into the lower anterior portion of the nasal cavity. When a cocain solution is employed, the patient should either assume an upright position, or an anterior position, to prevent the cocain from passing back into the posterior nares and being swallowed. Following the experiments of De Terra, Escat and Lederer added materially to the findings of De Terra. The author employs technic similar to that given, with the exception of the anesthetic solution. Instead of using a 5 per cent solution of cocain, a 20 per cent solution of procain is employed, and before the tampon is inserted, the mucous membrane which covers the lateral and mesial walls of the nares is thoroughly massaged to produce active hyperemia of the part, which will greatly facilitate absorption, thereby hastening and producing deeper anesthesia.

"Dental Materia Medica and Therapeutics" by Prinz quotes as follows:

"In order to explain this form of anesthesia, Escat offers the following plausible explanation:

"1. The infiltration of the floor of the nose, the penetration through the mucous lining and the osseous lamina or bone, and the absorption by the lymphatics carry the anesthetic solution to the nerves supplying the teeth.

"2. The cocain is taken up directly by these nerves, which furnish branches to the incisor and canine teeth.

"In order to explain the anatomical mechanism of this form of anesthesia, Claremont undertook the study of a large number of specimens. He has found the anterior superior dental branch of the superior maxillary nerve, which supplies the central, lateral and cuspid teeth, giving off a nasal branch supplying the mucous membrane of the anterior portion of the nasal cavity, is not enclosed deeply in the substance of the maxilla, but runs in close proximity to the floor of the nasal cavity. In 29 specimens of a series of 55, he found the canal normally formed, but with an extremely thin upper lamina—so thin that it was transparent and easily pierced—in 13 cases the canal was really a groove, and it lacked the upper wall or lamina. This intimate relationship of the anterior superior dental nerve with the nasal mucous membrane explains satisfactorily the anesthesia of the upper teeth following anterior intranasal anesthesia. In 47 per cent of the cases the cocain tampon is separated from the anterior superior dental branch by only the mucous membrane, and in 53 per cent the tampon is separated from the nerve by a very thin lamina of the osseous tissue, through which, it is easy to conceive, that the anesthetic readily reaches the nerve.

"Insufflation anesthesia with cocain is not always reliable. Many patients, especially those who are anemic, and extremely nervous, are highly reactive to cocainization of the nose, and frequently complain of a feeling of general malaise, lasting for hours after the anesthetization."

In a number of cases the writer has secured excellent results in producing anesthesia of the anterior superior dental nerve by the anterior intranasal method, using a 20 per cent procain solution. If the operator employs a procain solution of 20 per cent, the patient will not present any toxic symptoms, as may occur when cocain is employed. In case anesthesia is desired in the upper six anterior teeth, it is necessary to pack both the right and left nasal fossæ with tampons. In most cases excellent anesthesia can be produced in the centrals and laterals, but only a partial anesthesia in the cuspids, due to the communication of branches from the middle superior dental. In most cases it is necessary to block the naso-palatine nerve on the lingual side, whereas in many other cases sufficient anesthesia is secured from the tampon so far as the naso-palatine nerve alone is concerned. It must be remembered that the lingual side of the cuspid tooth is supplied not only by branches from the naso-palatine, but branches from the anterior palatine, and the application of the tampon in the nares does not block the anterior palatine nerve fibers unless there is sufficient amount of solution to permeate the floor of the nasal cavity in that region, and reach the terminal branches of the anterior palatine nerve lingual to the cuspid. The lingual side should be carefully tested before starting to operate, and, unless deep anesthesia has been secured, the nerve supply should be blocked by the method described on pages 511 and 512. In case deep anesthesia has not been secured in the cuspid tooth by the intranasal insufflation method, then a terminal or infiltration injection is made to the labial and distal of the apex of the cuspid to block the communicating or overlapping branches from the middle superior dental. (See technic, page 481.)

Uses of Insufflation Method.—The intranasal tampon method is of value for dental and oral operations, and, in conjunction with the intraoral second division or infraorbital injections, for antrum operations, etc. (See pages 694, 695 and 724 for producing anesthesia for maxillary sinus operations.)

INTRAVENOUS AND INTRAARTERIAL METHODS OF PRODUCING ANESTHESIA

The writer will not discuss in detail the intravenous, intraarterial and spinal methods of local anesthesia, as they are of little value to the oral surgeon or dental practitioner. If the reader is interested in methods other than those pertaining to the blocking of the nerves of the head and neck, he is referred to standard textbooks or literature on these subjects.

Intravenous Method

Intravenous anesthesia is produced by injecting the anesthetizing solution into a vein distal to an applied tourniquet or between two tourniquets.

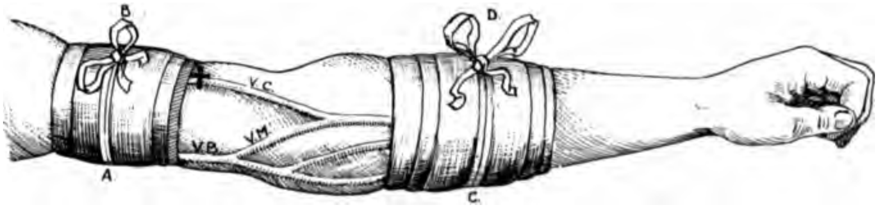


Fig. 470.—A-B, the proximal; C-D, the distal or peripheral bandage. V-B, vena basilica; V-C, vena cephalica; V-M, vena media; +, the place where the injection may be made in the cephalic vein and at a corresponding point in the basilic vein. The shading shows area of sensibility below the proximal bandage. (After Bier and redrawn from Allen.)

In 1908 this method of local anesthesia was described by Bier before the surgical congress. He injected the solution into the superficial veins under pressure, the point of injection being located between two tourniquets. (See Fig. 470.) Only one tourniquet is used if the injection is made distal to it. The solution is slowly injected into the vein, which readily passes through the tissues and within a few minutes profound anesthesia is secured. When Bier was experimenting with this method, he injected an indigo-carmin solution into the vein of an amputated limb and upon examination a few minutes following the injection he found the indigo-carmin had traversed the capillaries and turned them blue. He also demonstrated that following the injection of one-half per cent cocain solution into the vein of an extremity (the injection being located between two tourniquets) the parts became anesthetized within a very short time following the injection. He called this method of anesthesia, which was produced between the two tourniquets and was secured so quickly, "direct intravenous anesthesia," and that distal to the distal tourniquet "indirect intravenous anesthesia."

This method of anesthesia is applicable to all surgical operations on the extremities, such as amputations, bone curettements, removal of varicose veins, tumors, joint resections, etc.

In producing anesthesia by the intravenous method it is necessary that the tourniquets, which are in most cases made of rubber, produce complete ischemia. The technic for the operation, as given by both Bier and Haertell for producing intravenous injection, is as follows:

The limb which is to be operated upon is elevated and a thin rubber bandage is wrapped around the extremity, starting from the toes or fingers, and brought upward to a point near the lower part of the operation. After the lower part of the extremity has been rendered bloodless by the rubber bandage, a second rubber band is placed around the extremity just above the first bandage. The next step is to remove the first bandage which has been wrapped around the extremity starting at the toes or fingers, and upward, to a point distal to the field of operation, and at this point a third bandage should be wrapped very tightly around the part. If the technic has been correct so far, the field of operation which is located between the two tourniquets is isolated from the circulation on either side. The distance between the two tourniquets should not be more than ten inches or less than four inches. If the operation is upon the peripheral part of the extremity, one tourniquet is applied which should not be located above the middle third of the forearm or leg, except in cases for amputation. The next step in the technic is to select a large superficial vein which should be carefully located and mapped out, or expose the vein before the bandage or bandages are applied. The vein which is selected for the arm is the cephalic or the basilic, while the internal saphenous vein is selected for the leg. Most operators, who advocate this

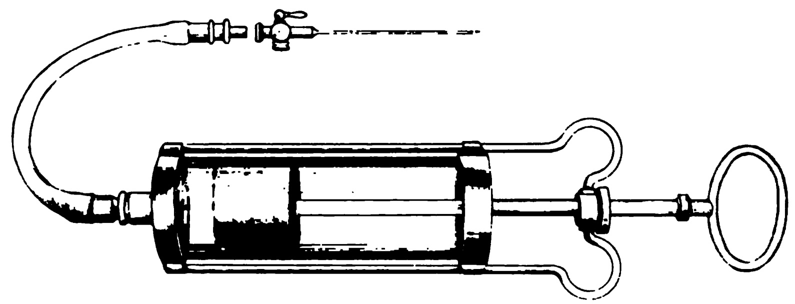


Fig. 471. Bier's syringe for intravenous anesthesia. (Redrawn from Braun.)

method, expose the vein before applying the tourniquet, which is done by making a small incision following infiltration anesthesia of the skin located just above the vein. The next step is to inject the anesthetizing solution into the vein between the two tourniquets. The anesthetizing solution injected into the vein in this manner comes in contact with all the nerve branches which produces anesthesia of all the parts and even beyond the distal tourniquet. The solution is injected by inserting a cannula into the vein and tying it in position.

A cannula mounted on a rubber tube, also a syringe, has been designed by Bier. (See Fig. 471). After the small cannula has been inserted into the vein, it is tied in the same manner as for injecting physiologic Ringer solution, with the exception that the cannula points towards the periphery, whereas, it points centrally when injecting physiologic saline solution. After the cannula is in place as described, the solution is slowly injected until the vein is under pressure. One-half per cent procain solution is used, which does not contain the vaso-constricting agent, adrenalin. The amount injected in the average case, is from 35 to 60 mils (cubic centimeters) in the arm or 60 to 100 mils (cubic centimeters) in the leg. However, the amount of solution depends upon the distance between the two tourniquets and the diameter of the part injected. Bier's special cannula contains a stopcock which is turned off when the proper amount of solution has been injected. The solution injected is prevented from escaping by placing a clamp upon the vein itself. After the solution has been injected under tension, the vein will be seen to distend, and in a few moments this distention will disappear and will signify that the solution has passed into the veins. A few minutes after the solution has been injected the part will be completely anesthetized, which is called "direct anesthesia." If the part to be operated is large, five to ten minutes should be allowed before the operation is started in order to obtain complete anesthesia of the sensory nerves distal to the distal bandage. This is called "indirect anesthesia" and will be complete throughout the entire section of the part injected. Anesthesia is maintained as long as the proximal tourniquet is kept in position, but just as soon as it is removed anesthesia quickly disappears. Therefore, it is always essential to complete the operation before the upper Esmarch bandage is removed. This method of anesthesia should be used for suitable cases, and is considered to be absolutely free from danger. Adrenalin should not be employed in the solution because it tends to impede the anesthetic action due to vaso-constriction, which prevents the solution from diffusing and permeating all parts of the tissue. Bier states that this method should never be employed in case of diabetic gangrene, advanced arteriosclerosis or senile gangrene, and he also questions its use in septic infections.

The longest operation which has been recorded is one and three-quarters hours. As soon as the bandage is removed, a most rapid disappearance of the anesthesia takes place, which is quickly followed by normal sensation. There has been very little written upon this important branch of local anesthesia, and if any deaths have occurred from this method, the author can find no record of them. This method of anesthesia has proved highly satisfactory for operations upon the extremities, and no doubt the future will reveal many interesting facts.

Bier operated upon 375 patients for amputations and reduction of fractures; Kaerger reports 152 cases in which this method of anesthesia was used. There is no doubt but that this ingenious method of Bier is a most valuable addition to local anesthesia and has its place in the anesthetic field but will probably never supplant other methods of nerve blocking.

Intraarterial Method

The intraarterial method of producing local anesthesia is accomplished by injecting the anesthetizing solution into an artery, distal to an applied tourniquet or between two tourniquets. It is similar to the intravenous method with the exception that an artery is employed instead of a vein.

Gayanes, a Spanish surgeon, in 1908 reported that he had produced anesthesia of a limb by injecting the local anesthetic solution into an artery, and in 1910 he reported that he had performed resections and amputations in 23 cases. Twenty cases were a complete success, while in three of them, only partial anesthesia resulted. Instead of using a cannula, as is the case with venous anesthesia, the solution is injected by means of a fine needle. Gayanes injected from 50 to 100 mils (c.c.) of a one-half per cent procain solution, obtaining anesthesia in the part in from five to fifteen minutes.

Intraarterial anesthesia has no advantages over the intravenous method, and one of the disadvantages which accompanies the method is that the artery to be injected is more difficult to reach in view of its deeper location.

Spinal Analgesia

Spinal analgesia, called spinal anesthesia by some operators, is a method which has attracted considerable attention since its discovery. It is defined as a method of producing anesthesia by injecting the anesthetizing solution beneath the membrane of the spinal cord. The publication of articles in the *New York Medical Journal* in 1885 on the experiments of Corning attracted the attention of the medical profession, and since that time the method has found a useful place in modern surgery.

In the experiments made by Corning upon dogs, after injecting a 2 per cent solution of cocain into the spinal canal, he was able to produce analgesia in a few minutes thereafter. Following his experiments upon dogs, his first practical case was that of injecting a man for genitourinary treatment. He injected 2 mils of a 3 per cent cocain solution, and a few minutes following the injection anesthesia was obtained and urethral sounds were passed. The patient experienced no pain, and a short time after treatment was able to leave the office with the area still anesthetized.

An American surgeon is again credited with adding another important link to the chain of anesthesia, for it is Matas, of New Orleans, who is given the credit for first performing an operation under spinal anesthesia. This operation was performed in the New Orleans Charity Hospital Clinic, December 18, 1899, by Professor Matas, assisted by Drs. H. B. Gessner, Carroll W. Allen, and F. A. LaRue. The operation was for hemorrhoids, upon a colored male and was successful.

When Corning was experimenting with the method, he depended upon the circulation to carry the anesthetizing solution to the cord. In other words, his object was to deposit the solution near the cord without puncturing its membrane. No doubt the needle entered the membrane because he secured perfect anesthesia following his injections. It would be difficult to understand how the solution could diffuse through the membrane which isolates the cord and a satisfactory analgesia be obtained without the solution being injected beneath the membrane. Following its introduction it soon became of interest and of almost general use in America. A great deal of enthusiasm displayed by the profession was soon followed by reaction, and the method was cast aside in many of the large clinics. However, a few research workers continued their investigations and put forth every effort to improve and develop the technic and to overcome its drawbacks. These workers have made known and presented some interesting facts to the profession which have resulted in improving this method of local anesthesia to an astonishing extent, yet it is not a method which can be used as a routine. However, it has its place in modern surgery and is very useful in certain cases. Cocain was the first anesthetic employed in producing spinal anesthesia, but it was soon found to be too dangerous and several deaths followed its use.

In 1894 Fourneau introduced stovain which became very popular and is used for this purpose to some extent today. However, it must be cautiously injected. Procain has not been very satisfactory for spinal analgesia, and is not used for that purpose to any extent.

There are three different points for making spinal injections, namely,

1. Between the second and third lumbar vertebræ.
2. Between the third and fourth lumbar vertebræ.
3. Between the fourth and fifth lumbar vertebræ.

The site of puncture for the injection depends upon the height of anesthesia required. It has been found that the most favorable site is in the lumbar region. If a low anesthesia is desired, the needle is inserted between the fourth and fifth lumbar vertebræ; for a high anesthesia, between the second and third lumbar vertebræ. The height to which anesthesia extends also depends upon the amount of the anesthetizing solution injected and the amount of the anesthetic drug contained in the solution. Following an injection anesthesia in most cases takes place rapidly and in the following order: Perineum, external genitalia, posterior surface of the thighs, legs, feet, anterior surfaces of the thighs, umbilicus, and costal arch. A spinal injection produces a complete nerve block and inhibits the transmission of sensory nerve impulses from the periphery to the brain, thereby preventing surgical shock. This method of nerve blocking demands highly developed technic and a high degree of watchful supervision over the patient. It should always be performed by a trained anesthetist or surgeon, and should never be attempted by any one who is not familiar with the technic.

The author does not feel that this method of nerve blocking should be discussed in detail in a work of this kind, for the reason that this volume is intended for the oral surgeon, general practitioner, and eye, ear, nose and throat specialist, and if the reader is desirous of becoming familiar with spinal analgesia, he is referred to standard works upon that subject. (See page 26.)

CHAPTER XXVIII

TERMINAL, PERIPHERAL OR INFILTRATION METHOD OF PRODUCING ANESTHESIA

These three terms have practically the same meaning. In a general way this method can be defined as one which produces anesthesia of the terminal or peripheral endings of the sensory nerves by an anesthetizing solution injected into a circumscribed area. It is of value not only in general surgery, but in oral, plastic, and dental surgery.

Strictly speaking, infiltration anesthesia, which was first described by Schleich, is the method of rendering the terminal nerve branches insensible to pain by saturating the tissues in a circumscribed area with the anesthetizing solution. Terminal or peripheral anesthesia has the same meaning, with the exception that the terms peripheral and terminal are anatomical terms, while the word "infiltration" relates to physics.

Local anesthesia is divided into two large classifications:

1. Anesthetizing the sensory, peripheral or terminal nerves and end organs.
2. The blocking method which obstructs the path of all the afferent sensory impulses in the nerve trunks that connect the field of operation with the brain.

CLASSIFICATION OF TERMINAL, PERIPHERAL OR INFILTRATION METHODS

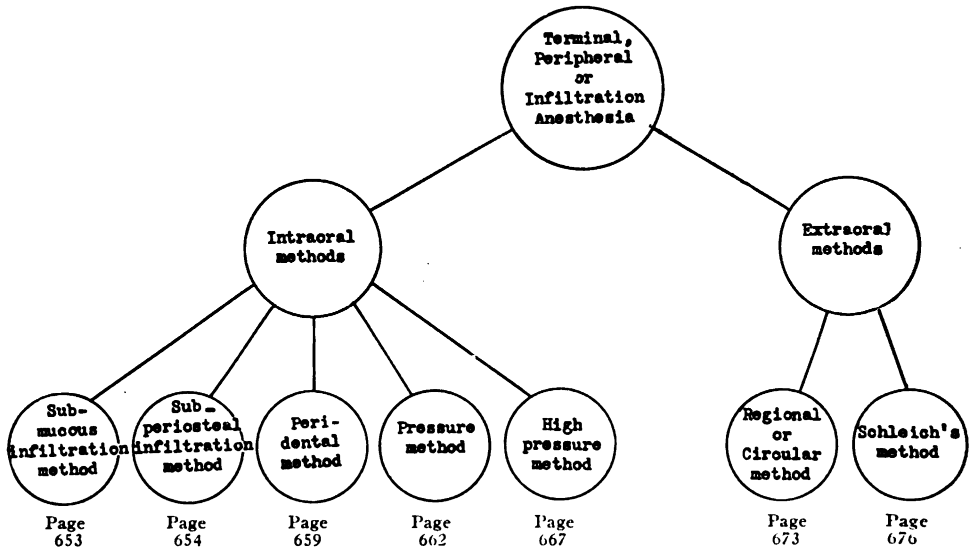
The reader will observe from the accompanying outline that the terminal, peripheral or infiltration method is first divided into extraoral and intraoral and then into seven different methods.

After discussing terminal, peripheral or infiltration anesthesia, each subdivision, as given in the outline, will be discussed in its respective order.

When the anesthetizing solution is injected by the terminal, peripheral or infiltration method, the local anesthetic acts upon the delicate sensory nerves and their end organs in a circumscribed area, thus producing insensibility to pain. The term "infiltration" relates to physics and simply means the diffusion of the solution through the tissues at the point of injection, regardless of its location, to anesthetize small nerve branches or a nerve trunk, such as by the perineural method. Therefore, the word "infiltration anesthesia" relates to the mode of injecting, while the anatomical terms peripheral and terminal pertain to the location of the injection.

In terminal anesthesia the solution is deposited in the immediate region of the terminal nerve endings, and through the process of diffusion the solution readily permeates the nerve fibers. If the solution is injected beneath the skin, the method is called endermic infiltration anesthesia. If the solution is injected beneath the mucous membrane encircling a circumscribed area, it is called submucous infiltration anesthesia.

The infiltration method of producing local anesthesia in a circumscribed part through the medium of a local anesthetic was first introduced by Halstead and Hall in 1885. Infiltration anesthesia may be employed in almost any portion of the body. In general surgery, it is of great value when the operating area is located superficially, therefore allowing a large quantity of the solution to be injected. For such operations as the removal of furuncles, opening of abscesses, removal of foreign bodies, and similar operations, deep anesthesia in most cases can be secured. Within the last few years operations for inguinal hernia, appendicitis, and numerous other operations, have become quite popular under local anesthesia, and it is customary to first block the terminal nerves by the terminal or infiltration method where the incision is made. After the incision through the skin, the injections are continued either by the deep block or infiltration method, this depending on the location of the operation and the nerve supply to the part involved.



Note: For complete classification of local anesthesia, see page 33.

A local anesthetic solution injected by the terminal or infiltration method produces anesthesia in the following ways:

1. By chemical action of the anesthetic drug upon the terminal nerves.
2. By the pressure exerted upon the sensory nerve endings by the solution. The latter is a minor factor in the production of anesthesia because the anesthetic drugs act upon the nerve tissue and produce insensibility.

If a large amount of solution is to be injected, usually a one-half per cent procain, 1/50,000 adrenalin in a Ringer vehicle is employed. This solution has a very low toxicity, and two or three ounces can be injected with safety in most cases. The author prefers a 1 per cent solution of procain instead of the one-half per cent. However, only half as much can be injected as that of the one-half per cent solution. It is impossible for the solution to produce immediate anesthesia; therefore, the operator must allow at least ten minutes to elapse before operating. Some operators make the mistake of attempting to operate before the tissues are thoroughly anesthetized. In most cases it will take ten minutes for the solution to diffuse through the tissues, reach the nerve branches, and block the afferent sensory impulses.

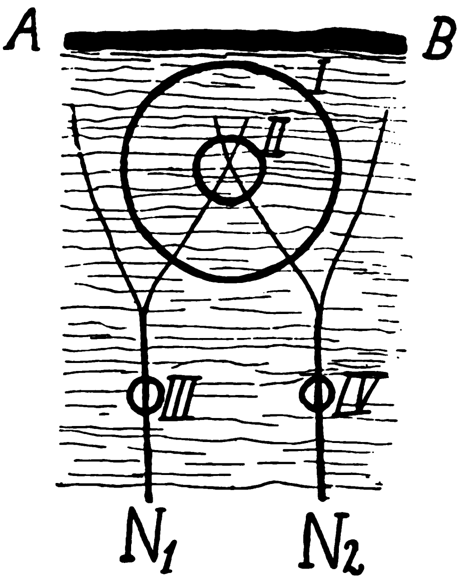


Fig. 472. -Schematic diagram of methods of anesthesia. (After Braun.)

For the removal of a cyst, benign tumor, or other local new growth, this method is ideal in many cases, and the secret of success not only lies in using a sufficient quantity of the solution, but also waiting a sufficient length of time before operating, and last, but not least, the technic of injection should be such as not to inflict any pain whatever upon patients during the injection or while operating. Braun's description of this form of anesthesia is as follows:

"The schematic cross section, as shown in Fig. 472, represents the surface of any part of the body; the line A-B representing skin, mucous membrane, serous membrane, or synovial membrane, on the surface of the body, or lining one of its cavities. N-1 and N-2 represent two sensory nerve trunks ramifying the tissues, and as usual overlapping one another in their area of distribution, so that a certain area is innervated by the terminal branches of several nerves.

"We shall now attempt to anesthetize the circular area marked No. 1 with an active anesthetic substance. Area No. 1 can be rendered insensitive by bringing the sensory endings in contact with a sufficient quantity of an anesthetic, which will inhibit their function. This is called terminal anesthesia and can be brought about in several ways.

"1. A solution of an active substance is injected into the tissues under slight pressure, so that area No. 1 is thoroughly saturated with the solution, replacing the normal tissue fluids. The molecules of the dissolved substance, mechanically injected, immediately come in contact with the tissue elements and promptly give evidence of their uniform action in the entire area. A chemical action will also be observed when the solution is diluted to the lowest limit of activity of the dissolved substance; this type of infiltration is seen in the skin wheal and has been designated by Schleich as infiltration anesthesia. The duration and intensity of this anesthesia is in proportion to the change produced in the nerve substance and strength of the solution. The more concentrated the solution, the longer the duration of the anesthesia. The duration and intensity of the anesthesia are the same in the entire area as the nerve elements have been equally affected.

"2. In the area designated in the figure by No. I, other methods can be employed for producing terminal anesthesia. If an anesthetic solution be injected in the center of the area represented by No. II in the diagram, the same local conditions will occur in this area as have been mentioned for infiltration anesthesia. Whether the solution has the same or different osmotic pressure than the blood, there now takes place an exchange of molecules between the dissolved substance and the salts in the tissue fluids. The former diffuse with more or less rapidity, depending upon their diffusibility, the permeability of the membranes surrounding the area, and the concentration of the solution affecting the tissues after a certain time in the entire area designated in the diagram by No. I, producing the same symptoms as originally took place in the center of the area designated by No. II. A difference nevertheless exists, as the solution during the process of diffusion becomes constantly more dilute, containing less of the active substance owing to portions of it being combined with the tissues the farther it is removed from the place of injection. In consequence of this, in a given case the intensity of anesthesia will diminish from the center towards the periphery in the area marked No. I in the diagram. The action by diffusion of a substance can scarcely be expected if the solution is so dilute that the dissolved substance is only sufficient for producing anesthesia in the area infiltrated, the number of molecules capable of diffusion into the surrounding tissues being too small to be effective. Therefore, it is necessary that small quantities of a concentrated solution be used to produce in this manner a local anesthetic effect, the same as if the entire area designated No. 1 had been infiltrated. This is the so-called indirect infiltration anesthesia.

"An anesthetic solution, when placed upon the surface A-B, can by means of diffusion, reach the nerves in the area designated No. I. Local anesthetic action can, however, only occur when the protecting membrane is permeable to the solution, and the solution much more concentrated than that used for injection.

"Local anesthetics can affect the function and conductivity of nerve trunks at points remote from their area of distribution, as when solutions are injected into the region of the nerve trunks, No. III and No. IV supplying area No. I. By means of diffusion their conduction will be interrupted, causing the so-called conduction anesthesia in this area. With the use of very weak solutions the nerve must be injected directly, diffusion under these circumstances being insufficient to interrupt conduction. The results of diffusion require waiting a certain time for anesthetic action.

"If an anesthetic substance is injected into an artery or vein, the circulation of which has been interrupted, terminal and conduction anesthesia will occur in the area of distribution of the respective vessels (arterial and venous anesthesia)."

General Principles of Technic of Terminal, Peripheral or Infiltration Anesthesia

If the solution is properly injected, this is a valuable form of local anesthesia. It may be used for such operations as appendicitis, hernia, plastic surgery, oral surgery, and dental operations. When terminal anesthesia is employed, the injections must be carefully considered and the area of operation outlined in detail.

The operator should be familiar with the nerve supply of the part, and must have a definite picture of what nerves are located in the part, their exact location and relation to each other. It is difficult to outline a definite procedure to follow, because this will depend upon the location, the extent and nature of the operation, the type of patient, and the diameter and location of the nerves to be infiltrated.

General Clinical Application—Terminal, Peripheral or Infiltration Anesthesia

It matters not whether the injection is to be made for some operation involving the skin, or whether it is located within the oral cavity and involves the mucosa, a well-defined technic must be followed to make the injections without inflicting pain upon the patient. Take, for example, the removal of a benign tumor situated beneath the skin, or some other operation for plastic surgery of the head; the first step in the technic is to render the part as aseptic as possible. This has already been described, but we will briefly mention here that the part to be injected should be thoroughly cleansed with soap and water, followed by thorough drying; then the application of tincture of iodin. Another efficient method is to apply ethyl alcohol to the skin, and follow with tincture of iodin. The skin is highly sensitive, and care must be exercised while making the initial puncture into the skin so as to eliminate all pain while inserting the needle especially if the patient is hypersensitive. A patient will experience considerable pain if a needle of large diameter is thrust through the skin without using means to eliminate the pain accompanying the initial puncture. However, some individuals may not complain during terminal or infiltration injections while the needle is being inserted and solution injected, while others may complain of slight pain, and it is with these individuals that we must exercise care in carrying out the technic. An operation performed entirely without pain means very much to an individual of a nervous temperament.

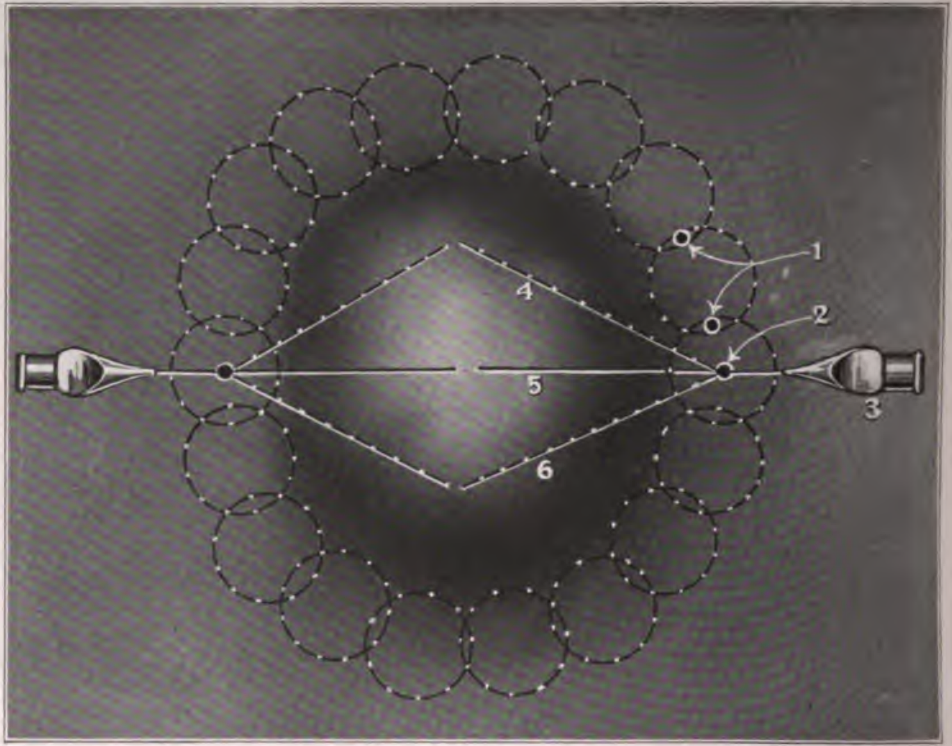


Fig. 473.—Illustrating a tumor or new growth and the manner in which the injections are made by the circular or regional method.

2, Initial puncture where preliminary injection is made. 1, Represents points of injection following preliminary injection. Each circle indicates an injection. 2, Common starting point for needle marked 3, 4, 5 and 6 shows the needle in various positions.

Technic of Injection.—The first step in the technic is to employ a needle of the proper length and diameter. The needle employed is No. 7, 10 mm. in length, and 27 gauge. The needle should be very sharp to facilitate its advancement beneath the skin surface. Before inserting the fine sharp needle, the operator should grasp the skin at the point of injection, between the thumb and index finger, hold it firmly and exert considerable pressure for at least one minute. This gradual pressure produces anemia, and the pressure exerted upon the sensory nerve endings has a paralyzing effect. After this has been accomplished, insert the fine needle with a quick thrust beneath the skin surface only, holding the needle at an acute angle to the cutaneous surface. If this is done carefully, the patient will experience no pain. With the needle point located just beneath the surface of the skin, one-half mil of the solution is slowly injected. The first solution should be injected intradermally and not subcutaneously. The injection of one-half mil will produce a distinct wheal. The solution injected will come in contact with the nerve endings in the papillary layers of the skin. After waiting one minute the needle is advanced through the skin and one-half mil is injected subcutaneously. A fine, sharp needle is only necessary for the first injection, after which needle No. 4 is employed. After a lapse of three minutes it is inserted within the margin of the wheal of anesthetized tissue. (See Fig. 473.) The tissue in region of wheal is insensitive within three minutes after injection. Care should be taken, while injecting the solution for each primary injection, that the needle point does not penetrate the subcutaneous tissue, because the solution may infiltrate laterally and not thoroughly permeate the skin. Very little ischemia is produced in the skin if the solution is injected subcutaneously. The initial wheal which has been produced, and the anesthesia which has followed, is called the "primary starting point" from which the other injections are made. (See Fig. 473.)

With the production of an area of anesthesia it is possible to make as many injections as desired, painlessly. If the operator is skillful with his technic, he will many times be able to advance the needle forward endermically and anesthetize a considerable area before removing the needle, but in so doing the solution must be injected continuously. In other words, the solution should be kept in advance of the needle and plenty of time should elapse after each injection while advancing the needle beneath the skin. After the initial wheal has been made, the next step is to produce a second wheal by inserting the needle within the periphery of the wheal of anesthetized tissue, being careful not to insert the needle beyond the anesthetized skin or mucosa. (See Fig. 473.) The second puncture is made absolutely without pain to the patient. As the needle is advanced through the skin for each injection, one mil of solution should be injected. After the second wheal has been produced, the needle is again removed and the technic repeated.

The number of wheals or areas of injection depend upon the nature and extent of the operation. If the operation is a minor one, which involves a small amount of tissue, only a small number of injections are necessary. On the other hand, if the operation involves a large area of tissue, then a large number of injections are essential to encircle the operative field. The amount of solution injected for each insertion of the needle will vary from one-half to one mil, and if procain is employed, it will be found that one per cent solution with 1/50,000 adrenalin in a Ringer vehicle will give ideal results.

If the operation involves the subcutaneous and other deep tissues, it will be necessary to inject the solution as previously described, encircling the area, and then injecting beneath the operative field, as described below, always giving ample time for the solution to anesthetize the tissue before thrusting the needle deeper.

Rapidity of Anesthesia by the Terminal or Infiltration Method

The rapidity with which anesthesia takes place is dependent upon a number of factors, among which the most important are:

1. The strength of the solution.
2. The amount of solution injected.
3. The amount of adrenalin or suprarenin employed.
4. The tension under which the solution is subjected in the tissues.
5. The location of the operation and the structure and normality of the tissues in which the solution is injected.

An example of obtaining a quick anesthesia following injection would be for an operation upon the scalp. When the scalp is infiltrated with the solution, anesthesia is profound within three or four minutes following the injections. This is also true for plastic operations upon the face from the fact that the skin and underlying tissue are limited in thickness, which is not the case in other parts of the body. It takes longer to obtain anesthesia if the solution has been injected in the arm or leg, because considerable connective tissue and fat are present. If it is found necessary to inject the solution deep into the tissue, in addition to the endermic and subcutaneous injections, as above described, a long needle of small diameter only should be employed. Insert the needle through the anesthetized tissue beneath the operative area (see Fig. 473) and inject one mil of solution continuously. Then withdraw the needle, but do not take it out of the tissue, change its direction by advancing to the side of the previously injected tissue. This is repeated as many times as is deemed necessary to distribute the solution into the deep tissues. However, three times will be found sufficient in most cases. In this manner a large quantity of solution can be injected into the deep tissues without removing the needle, thus avoiding many unnecessary punctures of the skin or mucosa. (See Fig. 473.) The operator should always remember that to discharge the solution rapidly from the syringe causes pain and trauma. This can be obviated by discharging the solution very slowly, which will eliminate rapid distention of the tissues, and give the anesthetic time to act upon the sensory nerve endings. It is not always necessary to inject the solution in a circular fashion around the area of operation, as shown in Fig. 473, for in many cases two punctures can be made, and then the needle inserted in different directions, injecting the solution continuously. The two punctures are made on both sides of the operative area and the solution injected so anesthesia will meet midway between the puncture points. This method will eliminate a number of punctures which are necessary when the circular method is employed. The operator should remember the degree of sensibility of the various tissues. The skin is highly sensitive and muscle tissue is practically insensitive to pain. Periosteum in most regions is very sensitive, while in other regions it has no sensibility. In most cases the bones are supplied with sensory nerves coming from the periosteum. If the periosteum is stripped from the bone, the outer surface of the bone is rendered insensitive.

The statements previously made have dealt principally with anesthesia of the skin and deeper structures, so the anesthetizing of the mucous membrane will now be discussed.

Anesthetizing the Mucous Membrane

The anesthetization of the mucous membrane is produced by three methods:

1. By applying the anesthetizing solution or powder to the mucous membrane.
2. By deep block anesthesia.
3. By terminal, peripheral, or infiltration anesthesia.

1. Surface anesthesia is produced by applying the solution or powder to the mucous membrane. In most instances this is accomplished by using a 20 per cent procain or a 10 per cent cocain solution. Procain is preferred from the standpoint of safety. The solution recommended to be used in this manner is as follows:

℞	Phenolis,	Gram 1
	Procainae pulvis	Grams 6
	Aqua dest.	Mils 30

Misce. Add 1 minim 1/1000 solution of adrenalin per mil at the time of using.

This is applied to the mucosa by means of cotton on a wooden applicator after it has been dried by gauze and compressed air. After waiting for three minutes, a second application is made. Repeat this procedure at least three times, and a surface anesthesia will be produced, which is sufficient for the application of ligatures, dam clamps or starting nerve block needle in case the patient is hypersensitive.

2. The second method, which is that of nerve blocking, will not be discussed here, as it has already been covered under block anesthesia.

3. Terminal or infiltration anesthesia is a very quick and efficient

method of producing anesthesia of the mucous membrane, gum tissue and periosteum. The solution should never be injected into inflamed tissue but around the inflamed area. Take, for example, an acute alveolar abscess which has caused considerable swelling and inflammation of the gum tissue and mucosa, and it is desired to insert the lancet to drain the part. If for a good reason the operator deems terminal anesthesia superior to the deep nerve block method, the solution should be injected around the inflamed area by inserting the needle in healthy tissue in different directions, and injecting the solution in advance of the needle. The area may be anesthetized by inserting the needle two or three times, and after it has entered the tissue, it should be slightly withdrawn and its direction changed. If this is done the solution will readily infiltrate from the part into which it is injected and through the area of inflammation. The author recommends that the deep block method be employed if possible in preference to the infiltration method. The infiltration method is valuable in many cases for such operations as those involving the soft tissues not complicated by infection, as for the removal of a benign tumor, epulis, cyst, ranula, malposed teeth, etc. This method of anesthesia is efficient for the majority of small tumors and cysts located in the floor of the mouth or upon the buccal surface. If the operation is for the removal of a ranula, the mucosa around the ranula is first injected as above described, followed by second injections in the wall of the cyst so that the capsule can be excised. If the area of operation involves considerable pathological tissue, which is often the case in tumors or cysts, or other pathological conditions which are located within the oral cavity, it is in most cases advisable to block the nerve branches by the deep block method and combine these deep nerve block injections with the above described infiltration or terminal injections. The oral surgeon should select infiltration anesthesia only after ruling out the deep nerve block method, because the deep nerve blocking injections have many points of advantage over infiltration or terminal anesthesia. The operator must remember that when injections have been made into the mucosa or gum tissue, there will be in most cases a blanching of the part which is a good indication that anesthesia is certain. Anesthesia usually develops very quickly, but the operator should be careful not to start the operation until he is positive that anesthesia is complete. The extent of anesthesia can be tested very easily by pressing upon the tissues with the needle or a sharp lancet. There is a possibility of the solution escaping through fistulous openings and through the sockets of adjoining teeth, or even into the soft spongy gum tissue. In case the solution has escaped from the desired location, the deeper structures will retain their sensibility, and if an incision is made the patient will experience pain.

The following points should be carefully observed in order to secure the greatest success from terminal, peripheral or infiltration method for anesthetizing the tissues within the oral cavity:

1. Complete anesthesia depends upon thorough infiltration of the tissues.

2. The injecting solution should contain from ½ to 2 per cent procain, the percentage being determined by the nature of the case, and 1/50,000 solution of the vasoconstricting agent. This should maintain anesthesia for at least 30 minutes.

3. The solution should be injected slowly.

4. Too much solution produces, at first, a burning pain due to the overtension of the tissue.

5. The solution should be injected as the needle is advanced in the tissue, and sufficient time should be allowed for the anesthetic to take effect.

6. The pain caused by the initial puncture should be eliminated by using a very fine sharp needle and slowly injecting one-half mil of solution just beneath the skin surface.

7. The solution should never be injected into inflamed or infected tissue.

8. If the needle is advanced beneath the periosteum it should be carefully done, and the solution injected slowly to avoid trauma and after-pain due to distention of the periosteum and other tissues.

9. Always avoid unnecessary punctures of the mucosa or gum tissue.

10. Always inject a sufficient quantity of solution and wait a sufficient length of time after injecting, to allow the solution to anesthetize the sensory nerve endings.

Contraindications for Terminal, Peripheral or Infiltration Anesthesia Within the Oral Cavity

1. For the removal of a malignant tumor.

2. In case considerable inflammation, swelling and infection are present this method should not be employed.

3. In case the involved tissues extend over a considerable area, which would demand a large quantity of the solution, deep block anesthesia is far superior.

4. In case of curettement of bone or the extraction of teeth, in addition to operating upon the soft parts, the deep nerve blocking method is preferable.

5. In case it is impossible to block a large operative area by surrounding it with the solution, deep block injections or a general anesthetic is indicated.

THE SUBMUCOUS METHOD OF PRODUCING ANESTHESIA

The submucous method of local anesthesia is a subdivision of the terminal, peripheral or infiltration method. It is the method of producing anesthesia by injecting the anesthetizing solution into the mucous membrane or gum tissue in the immediate field of operation. Most operators, when they speak of the submucous method, have reference to the injecting of the solution beneath the periosteum covering the alveolar process. Strictly speaking, this is not correct, as when the solution is injected beneath the periosteum it should be called the subperiosteal method, which is described below. The submucous method was at one time employed to a considerable extent, but it has been succeeded by the subperiosteal, peridental, and other methods, this being due to the fact that it was inefficient, as only partial anesthesia was produced in many cases. The technic which has been employed for this method was not scientific. The needle was inserted promiscuously a number of times into the gum tissue and mucosa around the tooth or part to be operated, and the solution injected. Most operators, who injected the solution by this method, employed a needle of large diameter, approximately 10 millimeters in length, mounted on a curved hub. The needle was inserted promiscuously into the gum tissue surrounding the tooth, producing numerous punctures. The solution was injected external to the periosteum in most cases, and only light anesthesia of the deeper structures was produced. Failures were due to the fact that very little solution ever penetrated the periosteum and alveolar plate to anesthetize the nerves situated in the middle cancellous bone. The numerous punctures around the tooth caused considerable postoperative soreness and discomfort, and in some cases produced sloughing of the tissues and rendered infection more liable.

The injection of the solution by this method was first employed shortly after the discovery of cocain, and some operators who practiced this method were under the impression that they were using block anesthesia; but if the chart on page 33, and the definition of block anesthesia on page 194 are studied, it will be found that injecting the solution by the submucous method is not in the strict sense nerve blocking.

THE SUBPERIOSTEAL METHOD OF PRODUCING ANESTHESIA

The subperiosteal method of producing anesthesia is accomplished by injecting the solution beneath the periosteum, that is, depositing the solution between the periosteum and the bone. If this method is followed in the proper manner, very gratifying results will be obtained. The subperiosteal method is a division of terminal, peripheral or infiltration anesthesia. (See page 644.) By the submucous method, the solution is injected external to the periosteum and reaches the terminal nerve endings located in the middle alveolar plate, and the apices of the teeth by the process of diffusion. On page 428 the writer discusses the advantages and disadvantages of infiltration anesthesia, and at this time it might be well to recall one of the statements made with reference to the age of the patient.

It was pointed out that in a patient of middle or past middle life, many times the infiltration method proved inefficient because of the dense outer alveolar plate of the process. This plate of bone may be so dense and nonporous that it prevents nearly all of the anesthetic solution from infiltrating it and reaching the desired structures. If the patient is young and has an external alveolar plate which is porous, it will be found that good results will be obtained from the subperiosteal method.

Advantages of the Subperiosteal Method.—The advantages of the subperiosteal method are as follows:

1. The anesthetic solution is deposited beneath the periosteum, and anesthesia is secured with less delay than when the solution is injected external to the periosteum.

2. If the point of the needle is actually inserted beneath the periosteum, and the solution injected slowly, the periosteum will have a tendency to hold the solution in a circumscribed area, and a larger amount will pass through the external alveolar plate.

3. In most cases only a small amount of solution is needed by the subperiosteal method.

Disadvantages of the Subperiosteal Method.—The disadvantages of the subperiosteal method are as follows:

1. Several punctures of the tissue may be necessary if more than one tooth is blocked. The solution is injected beneath the periosteum, and considerable pressure is required to discharge it from the syringe.

2. If a large quantity of the solution is injected, the periosteum will be separated from the bone, which will cause the severing of Sharpey's fibers binding the periosteum to the bone.

3. More pain is inflicted with the insertion of the needle than by the submucous method, because the needle is carried beneath the periosteum, which is more sensitive than the gum tissue and mucosa. In some cases it is difficult to keep the needle beneath the periosteum on account of the roughness of the external alveolar plate.

If the operator desires to make the subperiosteal injection following the technic described, it may be necessary to use some preliminary agent prior to the insertion of the needle. The three methods employed are as follows:

1. By local application of an efficient analgesic. An excellent combination for this purpose has been described on page 651. This solution can be applied to the gum tissue and mucous membrane after they have been thoroughly dried by gauze and the application of hot air. A small piece of cotton or gauze is saturated with the solution and held against the tissues for two minutes. In most cases this will produce profound anesthesia of the superficial parts, and no pain will be experienced by the patient during the insertion of the needle.

2. The second method is to make a superficial injection with a very fine sharp needle, such as illustrated in Fig. 177. The injection of five minims of solution is made into the tissue at the point of the subperiosteal injection. Gradually work the point of the needle downward in the direction of the periosteum, injecting five minims of the solution as the needle is advanced towards the periosteum. After massaging the part and waiting two minutes, the needle is inserted beneath the periosteum, where five minims of the solu-

tion are spent. This procedure, if carefully followed, will eliminate all pain. At least five minutes should elapse following the preliminary injection before the syringe needle is inserted for the subperiosteal injection.

3. The third method is the application of a refrigerant analgesic, such as ethyl chloride. A stream of ethyl chloride is directed upon the gum tissue or mucous membrane, and in a few moments surface anesthesia will ensue.

The writer has studied the literature on the subject of subperiosteal methods of producing anesthesia and is sure that credit for first calling attention of the dental profession to this method is due to Prinz. The technic described is a modification of the subperiosteal method described by Prinz.

The Technic for Producing Anesthesia by the Subperiosteal Method.—There are two methods for blocking an area by the subperiosteal method. The first is to insert the needle beneath the periosteum buccal or labial to the position occupied by the apex of the tooth and holding the needle parallel to the occlusal plane of the teeth. See Fig. 417. The second method is to insert the needle beneath the periosteum, holding it parallel to the surface of the alveolar plate, which is more or less parallel to the long axis of the tooth. See Fig. 474.

Technic Employed for Subperiosteal Method by Holding the Needle Parallel to the Occlusal Plane of the Teeth

The technic for producing anesthesia by this method has been described. See page 430 for blocking the middle superior dental nerve.

Blocking a Single Tooth by the Subperiosteal Method by Holding the Needle Parallel to the Long Axis of the Tooth

Needle No. 5, which is 15 mm. in length, is employed. The tissues at the point of injection are prepared for the needle in the same manner as given on page 555. The point of insertion of the needle, as first suggested by Prinz, is midway between the buccal or labio-gingival margin, and the apex of the tooth. He recommends that the needle be forced beneath the periosteum and a small quantity of the solution slowly injected, gradually forcing the needle upward in contact with the external alveolar plate, and injecting continuously while the needle is being forced upward. The author's technic differs from that of Prinz, as follows:

Make the initial puncture to the buccal and just below the position occupied by the apex of the tooth that is being blocked. Force the needle inward and upward, and just before the periosteum is reached, inject five minims of the solution, allowing one minute to elapse before advancing the needle beneath the periosteum. Gradually work the needle beneath the periosteum over the apex of the tooth being blocked, using, for example, the upper first bicuspid. Inject five more minims when the needle penetrates the periosteum, allowing one minute to elapse before advancing the needle beneath the periosteum. The needle is inserted in three different directions as shown in Fig. 474. Gradually advance needle marked 1 upward beneath the periosteum, parallel to external alveolar plate to an area 5 mm. above the apex of the tooth, and slowly inject five minims beneath the periosteum. Now withdraw the needle without removing it from the tissue, and insert a second time, directing it backward, upward and inward beneath the periosteum a distance of 5 mm. The needle should be inserted until the point reaches an area midway between the apex of the tooth being blocked and the apex of the tooth just posterior to it. Inject five minims. The needle is again withdrawn, and the technic repeated by directing it anteriorly, inward and upward beneath the periosteum, to a point mesial to the apex of the tooth being blocked. Fig. 474 shows the five points of injection. The total quantity of solution injected at the five points is twenty-five minims; five minims being injected at each location of the needle.

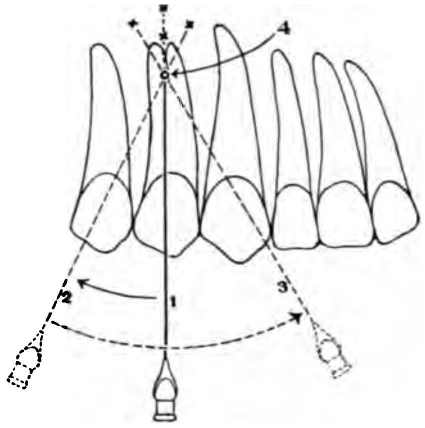


Fig. 474.—Diagram illustrating manipulation of needle for blocking a single tooth by the subperiosteal method.

1, Primary position of needle, which is moved to position 2 and 3 as indicated by arrows. 4, Circle represents common starting point. X represents the various points of injection.

BLOCKING VARIOUS INDIVIDUAL TEETH BY THE SUBPERIOSTEAL METHOD

If a single tooth is injected, the insertion of the needle in three different planes, as shown in Fig. 474, is preferred to that of inserting the needle parallel to the occlusal plane of the tooth, as shown in Fig. 317. However, if more than one tooth is to be anesthetized, it is better to make the injection by holding the needle parallel to the occlusal plane of the teeth, inasmuch as only one puncture of the tissue need be made, while if the method just described is employed, it will be necessary to make as many punctures as there are teeth involved.

speaking, this is not correct, as when the solution is injected beneath the periosteum it should be called the subperiosteal method, which is described below. The submucous method was at one time employed to a considerable extent, but it has been succeeded by the subperiosteal, peridental, and other methods, this being due to the fact that it was inefficient, as only partial anesthesia was produced in many cases. The technic which has been employed for this method was not scientific. The needle was inserted promiscuously a number of times into the gum tissue and mucosa around the tooth or part to be operated, and the solution injected. Most operators, who injected the solution by this method, employed a needle of large diameter, approximately 10 millimeters in length, mounted on a curved hub. The needle was inserted promiscuously into the gum tissue surrounding the tooth, producing numerous punctures. The solution was injected external to the periosteum in most cases, and only light anesthesia of the deeper structures was produced. Failures were due to the fact that very little solution ever penetrated the periosteum and alveolar plate to anesthetize the nerves situated in the middle cancellous bone. The numerous punctures around the tooth caused considerable postoperative soreness and discomfort, and in some cases produced sloughing of the tissues and rendered infection more liable.

The injection of the solution by this method was first employed shortly after the discovery of cocain, and some operators who practiced this method were under the impression that they were using block anesthesia; but if the chart on page 33, and the definition of block anesthesia on page 194 are studied, it will be found that injecting the solution by the submucous method is not in the strict sense nerve blocking.

THE SUBPERIOSTEAL METHOD OF PRODUCING ANESTHESIA

The subperiosteal method of producing anesthesia is accomplished by injecting the solution beneath the periosteum, that is, depositing the solution between the periosteum and the bone. If this method is followed in the proper manner, very gratifying results will be obtained. The subperiosteal method is a division of terminal, peripheral or infiltration anesthesia. (See page 644.) By the submucous method, the solution is injected external to the periosteum and reaches the terminal nerve endings located in the middle alveolar plate, and the apices of the teeth by the process of diffusion. On page 428 the writer discusses the advantages and disadvantages of infiltration anesthesia, and at this time it might be well to recall one of the statements made with reference to the age of the patient.

It was pointed out that in a patient of middle or past middle life, many times the infiltration method proved inefficient because of the dense outer alveolar plate of the process. This plate of bone may be so dense and nonporous that it prevents nearly all of the anesthetic solution from infiltrating it and reaching the desired structures. If the patient is young and has an external alveolar plate which is porous, it will be found that good results will be obtained from the subperiosteal method.

Advantages of the Subperiosteal Method.—The advantages of the subperiosteal method are as follows:

1. The anesthetic solution is deposited beneath the periosteum, and anesthesia is secured with less delay than when the solution is injected external to the periosteum.

2. If the point of the needle is actually inserted beneath the periosteum, and the solution injected slowly, the periosteum will have a tendency to hold the solution in a circumscribed area, and a larger amount will pass through the external alveolar plate.

3. In most cases only a small amount of solution is needed by the subperiosteal method.

Disadvantages of the Subperiosteal Method.—The disadvantages of the subperiosteal method are as follows:

1. Several punctures of the tissue may be necessary if more than one tooth is blocked. The solution is injected beneath the periosteum, and considerable pressure is required to discharge it from the syringe.

2. If a large quantity of the solution is injected, the periosteum will be separated from the bone, which will cause the severing of Sharpey's fibers binding the periosteum to the bone.

3. More pain is inflicted with the insertion of the needle than by the submucous method, because the needle is carried beneath the periosteum, which is more sensitive than the gum tissue and mucosa. In some cases it is difficult to keep the needle beneath the periosteum on account of the roughness of the external alveolar plate.

If the operator desires to make the subperiosteal injection following the technic described, it may be necessary to use some preliminary agent prior to the insertion of the needle. The three methods employed are as follows:

1. By local application of an efficient analgesic. An excellent combination for this purpose has been described on page 651. This solution can be applied to the gum tissue and mucous membrane after they have been thoroughly dried by gauze and the application of hot air. A small piece of cotton or gauze is saturated with the solution and held against the tissues for two minutes. In most cases this will produce profound anesthesia of the superficial parts, and no pain will be experienced by the patient during the insertion of the needle.

2. The second method is to make a superficial injection with a very fine sharp needle, such as illustrated in Fig. 177. The injection of five minims of solution is made into the tissue at the point of the subperiosteal injection. Gradually work the point of the needle downward in the direction of the periosteum, injecting five minims of the solution as the needle is advanced towards the periosteum. After massaging the part and waiting two minutes, the needle is inserted beneath the periosteum, where five minims of the solu-

tion are injected. This procedure, if carefully followed, will eliminate all pain. At least two minutes should elapse following the preliminary injection before the regular needle is inserted for the subperiosteal injection.

3. The third method is the application of a refrigerant analgesic, such as ethyl chlorid. A stream of ethyl chlorid is directed upon the gum tissue or mucous membrane, and in a few moments surface anesthesia will ensue.

The writer has studied the literature on the subject of subperiosteal methods of producing anesthesia and is sure that credit for first calling attention of the dental profession to this method is due to Prinz. The technic described is a modification of the subperiosteal method described by Prinz.

The Technic for Producing Anesthesia by the Subperiosteal Method.—There are two methods for blocking an area by the subperiosteal method. The first is to insert the needle beneath the periosteum, buccal or labial to the position occupied by the apex of the tooth, and holding the needle parallel to the occlusal plane of the teeth. (See Fig. 317.) The second method is to insert the needle beneath the periosteum, holding it parallel to the surface of the alveolar plate, which is more or less parallel to the long axis of the tooth. (See Fig. 474.)

Technic Employed for Subperiosteal Method by Holding the Needle Parallel to the Occlusal Plane of the Teeth

The technic for producing anesthesia by this method has been described. See page 430 for blocking the middle superior dental nerve.

Blocking a Single Tooth by the Subperiosteal Method by Holding the Needle Parallel to the Long Axis of the Tooth

Needle No. 3, which is 15 mm. in length, is employed. The tissues at the point of injection are prepared for the needle in the same manner as given on page 355. The point of insertion of the needle, as first suggested by Prinz, is midway between the buccal or labio-gingival margin, and the apex of the tooth. He recommends that the needle be forced beneath the periosteum and a small quantity of the solution slowly injected, gradually forcing the needle upward in contact with the external alveolar plate, and injecting continuously while the needle is being forced upward. The author's technic differs from that of Prinz, as follows:

Make the initial puncture to the buccal and just below the position occupied by the apex of the tooth that is being blocked. Force the needle inward and upward, and just before the periosteum is reached, inject five minims of the solution, allowing one minute to elapse before advancing the needle beneath the periosteum. Gradually work the needle beneath the periosteum over the apex of the tooth being blocked, using, for example, the upper first bicuspid. Inject five more minims when the needle penetrates the periosteum, allowing one minute to elapse before advancing the needle beneath the periosteum. The needle is inserted in three different directions as shown in Fig. 474. Gradually advance needle marked 1 upward beneath the periosteum, parallel to external alveolar plate to an area 5 mm. above the apex of the tooth, and slowly inject five minims beneath the periosteum. Now withdraw the needle without removing it from the tissue, and insert a second time, directing it backward, upward and inward beneath the periosteum a distance of 5 mm. The needle should be inserted until the point reaches an area midway between the apex of the tooth being blocked and the apex of the tooth just posterior to it. Inject five minims. The needle is again withdrawn, and the technic repeated by directing it anteriorly, inward and upward beneath the periosteum, to a point mesial to the apex of the tooth being blocked. Fig. 474 shows the five points of injection. The total quantity of solution injected at the five points is twenty-five minims; five minims being injected at each location of the needle.

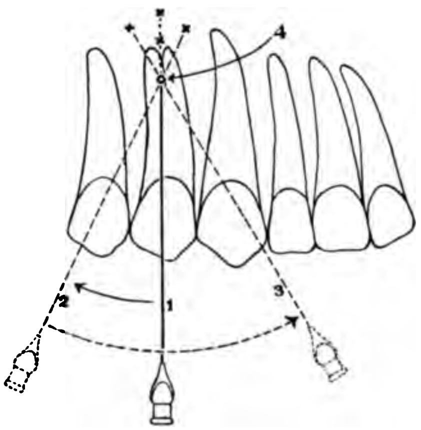


Fig. 474.—Diagram illustrating manipulation of needle for blocking a single tooth by the subperiosteal method.

1, Primary position of needle, which is moved to position 2 and 3 as indicated by arrows. 4, Circle represents common starting point. X represents the various points of injection.

BLOCKING VARIOUS INDIVIDUAL TEETH BY THE SUBPERIOSTEAL METHOD

If a single tooth is injected, the insertion of the needle in three different planes, as shown in Fig. 474, is preferred to that of inserting the needle parallel to the occlusal plane of the tooth, as shown in Fig. 317. However, if more than one tooth is to be anesthetized, it is better to make the injection by holding the needle parallel to the occlusal plane of the teeth, inasmuch as only one puncture of the tissue need be made, while if the method just described is employed, it will be necessary to make as many punctures as there are teeth involved.

This technic can be employed for any single tooth extending from the upper central incisors to the second bicuspids. This method should produce anesthesia of the tooth and alveolar process, unless the external alveolar plate is so dense that the solution will not penetrate it. Operations, such as cavity preparation, pulp removal, shaping the crowns of teeth for bridge abutments, can be performed. If a tooth is to be extracted, involving the lingual gum tissue and periosteum, it becomes necessary to block the lingual nerve supply, as follows:

Needle No. 4, 30 mm. in length, and 25 gauge, is employed. Direct the syringe across the mouth, the barrel being in contact with the occlusal surfaces of the teeth on the opposite side of the lower jaw. Puncture the gum tissue midway between the gingival margin and the apex of the tooth to be blocked. (See Fig. 475.) Force the needle upward and laterally, and just before the periosteum is reached, inject 5 minims of the solution. Wait one-half minute, then bring the syringe to the same side as that of injection, and carefully advance the needle, injecting 5 minims. Wait one-half minute before advancing the needle upward, the needle being held parallel to the linguo-alveolar plate and is advanced until the point strikes the hard palate, where the principal branches of the lingual nerve supply are located. (See Figs. 343 and 475.) When the hard palate is reached, inject 5 more minims.

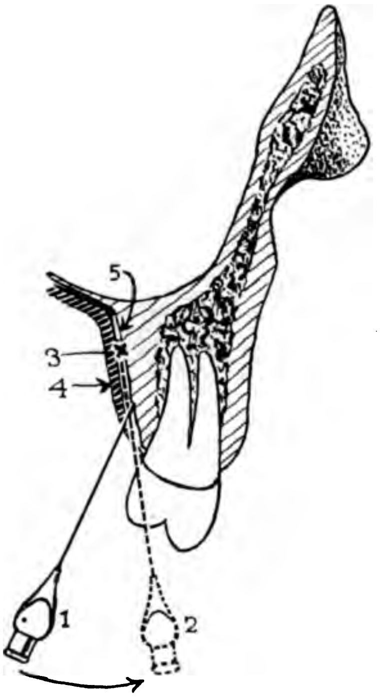


Fig. 475.—Cross section in region of upper bicuspid teeth and manner of manipulating needle for injecting solution over lingual plate.

1, shows first position of needle, and 2 illustrates needle parallel to lingual plate; 3 and X indicate point of injection; 4, lingual gum tissue; 5, periosteum and lingual alveolar plate.

This makes a total of 15 minims, or one mil. The nerves involved on the labial and buccal sides, or for the lingual side, depend on the area involved in the operation. It is rather difficult to anesthetize the upper first molar by the subperiosteal method, employing the technic in which the needle is held parallel to the long axis of the tooth, because of the position occupied by the upper first molar, which makes it difficult to manipulate the needle. Therefore, it is better to anesthetize this tooth by the subperiosteal method, by injecting the solution to the buccal of the external alveolar plate in the region of the apices of the buccal roots, and holding the needle parallel to the occlusal surface. Five minutes should elapse following the injection of the solution before operating. Considerable pressure is required to discharge the solution following this method, and it will be found that by moving the needle back and forth 1 or 2 mm., while the solution is being discharged, it will greatly facilitate the solution leaving the needle.

After the solution has been injected beneath the periosteum, no appreciable wheal should be present. If there is, it indicates that the solution has not been injected subperiosteally, but has been injected into the mucosa external to the periosteum. The reason no wheal is produced when injecting beneath the periosteum is that the periosteum is nonelastic, which is not the case with the mucous membrane. Soon after the solution is injected, the gum tissue and mucous membrane should lose their natural pink color and become blanched, which indicates that the pressure caused by the solution, also the therapeutic action of the vaso-constricting agent, has lessened the blood supply in the parts. After injecting the solution the parts should be gently massaged, directing the pressure downward and inward, assisting the solution to pass through the outer plate of bone.

Time to Wait for Anesthesia by the Periosteal Method.—The time to wait for anesthesia depends on the following factors:

1. The density of the alveolar process.
2. The amount of solution injected.
3. The percentage of the anesthetic contained in the anesthetizing solution.
4. The extent of the area to be anesthetized.
5. The operator's ability to inject the solution.

The average length of time required to produce anesthesia, if the solution is injected properly, is five minutes. The above technic will apply to any tooth or teeth in the upper jaw, anterior to the first molar. In some cases it may be employed in the lower jaw, but because the bone is more dense, failures are likely to be more prevalent; therefore, in most cases subperiosteal injections in the lower jaw are contraindicated.

BLOCKING THE TERMINAL OR PERIPHERAL NERVES BY THE PERIDENTAL METHOD

Definition.—Peridental anesthesia is the method of inducing insensibility of the peridental membrane and other immediate structures by the injection of a local anesthetic into the peridental membrane.

This method has been very popular in the past, and no doubt has been employed more than any other for producing anesthesia. Since the advent of the deep block method, the subperiosteal method, the intraosseous method, and other methods, a large percentage of operators have entirely abandoned the peridental method. It is true that with the syringe upon which great pressure can be exerted, and with a very sharp needle, the solution can be injected into the peridental membrane for single teeth or roots, satisfactory results being obtained in most cases. However, in some cases, if the tooth is decayed below the alveolar process, some difficulty may be experienced in producing a profound anesthesia so its root can be removed, and there is a chance of forcing infected material into the healthy tissues.

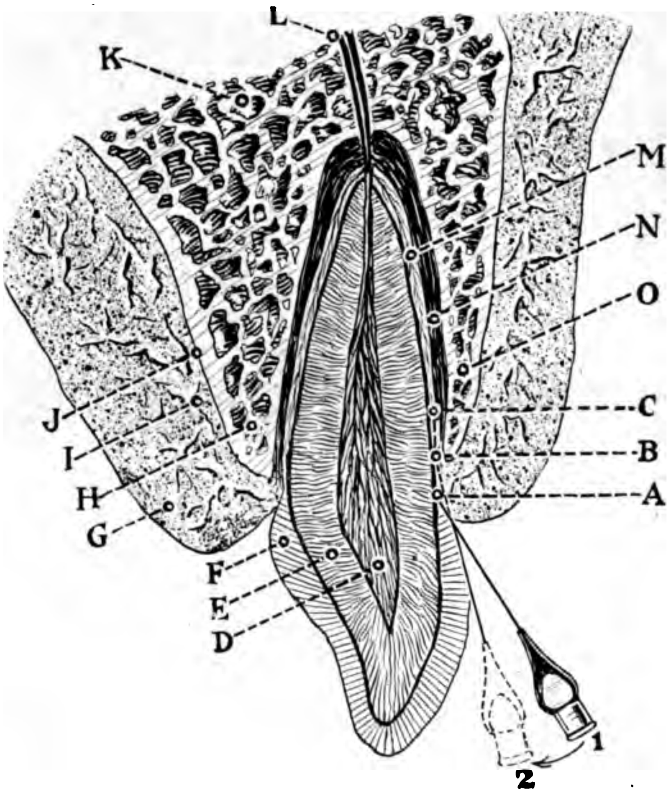


Fig. 476.—Diagrammatic cross section of central incisor tooth, alveolar process, gum tissue and mucosa.

1, Starting point of needle for peridental method. 2, Illustrating position of needle while advancing it into peridental membrane and injecting solution at A, B and C. D, dental pulp; E, dentin; F, enamel; G, epithelial surface of mucosa; H, lingual alveolar plate; I, submucosa; J, periosteum; K, middle plate of alveolar process; L, nerve, artery and vein; M, cementum; N, peridental membrane; O, external alveolar plate.

Technic Employed.—The syringe employed should be one upon which a great deal of pressure may be exerted against the plunger, as the solution is injected into the peridental membrane with considerable force. An all-glass syringe is contraindicated. The needle employed should be small, not exceeding 15 mm. in length, such as needle No. 3 shown in Fig. 177. This is a straight needle and is used for blocking any of the ten anterior teeth, but if the three molars are to be anesthetized by the peridental method, it is better to use a needle not to exceed 10 mm. in length, mounted on a curved hub. The tooth and the tissues nearby, which are to be anesthetized, should be thoroughly prepared for the needle by drying and then applying a 3½ per cent solution tincture of iodin. The initial puncture is made with a sharp hypodermic needle by first inserting it under the free margin of the gum on the labial or buccal surfaces. Only the point of the needle should be forced beneath the surface of the tissue, so that unnecessary pain will not be inflicted upon the patient, after which three minims of the solution are injected. After waiting for one-half minute, advance the needle into the peridental membrane, allowing it to assume a position parallel to the long axis of the tooth being blocked. (See Fig. 476.) Inject at this time three more minims of the solution and after waiting one-half minute the needle is forced into the peridental membrane between the alveolar wall and the tooth. Inject three more minims of the solution. It will be found in many cases, if the needle is held in the correct position, that is, parallel to the long axis of the tooth, that it can be inserted to a depth of approximately 5 mm. The needle is then withdrawn and the same technic repeated on the distal surface of the tooth. After injecting the solution on the distal side, repeat the same technic on the lingual and mesial surfaces, making four insertions of the needle. The total amount of solution injected for one tooth should be two mils. In most cases in single rooted teeth, such as the centrals and bicuspids, the lingual, labial or buccal injections are all that are necessary. If a molar tooth is being blocked, a more pronounced anesthesia will be produced if the solution is injected on the buccal, distal, mesial and lingual surfaces. If the injection is made on the buccal and lingual surfaces, it will be of more value than the mesial and distal injections, because the needle can be advanced farther into the peridental membrane of the buccal and lingual surfaces, due to the fact that the needle can be held parallel to the long axis of the tooth, whereas with the mesial and distal injections it is impossible to hold the needle parallel to the long axis on account of contact with the adjoining tooth. Greater pressure is exerted upon the plunger to discharge the solution into the peridental membrane than is required to discharge the solution beneath the periosteum by the subperiosteal method.

Advantages of the Peridental Method

1. The technic is very simple.

2. Very little knowledge of anatomy is required to inject the solution by the peridental method as compared with the deep block method.

3. A smaller area can be anesthetized by the peridental method than by any other, and satisfactory results can be obtained in most cases, provided the solution is properly injected and the physical condition of the patient justifies its use.

Disadvantages of the Peridental Method

1. The insertion of the needle into the peridental membrane produces injury which should not occur unless the tooth is to be extracted.
2. Considerable pressure is required to discharge the solution, causing more discomfort and pain than by other methods.
3. It is contraindicated if the peridental membrane is in a state of acute inflammation, or if infection is present, such as pyorrhea alveolaris or alveolar abscess. If the solution is injected by the peridental method in a case where infection exists, there is great probability of postoperative complications ensuing.

PRESSURE ANESTHESIA

Definition.—Pressure, contact, or pulp anesthesia is the method of bringing about a state of insensibility of the dental pulp by forcing the anesthetizing solution through the dentin into the pulp chamber by mechanical means. There are three methods of producing anesthesia by the pressure method which are:

1. Hand pressure, using unvulcanized rubber with a properly shaped appliance.
2. With an efficient hypodermic syringe.
3. With the high pressure syringe.

Ottolengui, in an article published in *Items of Interest*, in 1890, states that the term "pressure anesthesia" was first suggested by W. J. Morton. Following the experiments of Morton, Edward C. Briggs, of Boston, published the technic in a paper which he read before the Harvard Odontological Society in 1890, entitled "Removal of the Pulp by the Use of Cocain." Since Morton and Briggs presented their work to the profession, there have been a large number of claimants for this method of producing anesthesia of the pulp. It is not only true with pressure anesthesia, but with any invention or technic of merit, that priority is many times unjustly claimed by others. In going through the literature the author has found that many articles have appeared in our journals on anesthetizing the dental pulp by the pressure method. The more important contributions have emanated from W. J. Morton; E. C. Briggs; J. P. Buckley; R. Ottolengui; T. S. Phillips; R. C. Young; Otto Walkhoff; Clyde Davis; J. A. Johnson; H. J. Goslee; R. D. Pullar; J. DeBries; W. D. Miller; H. A. Sanders; L. H. Ziegler; E. T. Loemmler; W. A. Johnson; Weston A. Price; Herman Prinz; S. M. Weaver; C. G. Meyers; W. T. Jackman and Geo. N. Hein.

Histological Structure of Dentin.—Before discussing the technic of pressure anesthesia, a brief description of the histologic structure of dentin will be given, as it must be understood before the various methods of producing anesthesia of the dental pulp can be considered.

Dentin is the chief tooth substance which surrounds the dental pulp. It is covered by enamel on the exposed portion of the tooth and by cementum on the part situated in the alveolus. It consists of a solid, organic substratum, which is infiltrated with lime salts, and permeated by numerous tubules or canaliculi, which contain small processes or branches of the odontoblasts which line the pulp chamber. Dentin resembles bone, but it is much harder and denser. It is composed of 28.01 per cent of inorganic and 71.99 per cent of organic material. The inorganic substances furnish rigidity for hardness and resistance to tooth structure; the organic substances are largely instrumental in the nutrition of the tooth. Dentin is perforated by thousands of small branching tubules which radiate from the pulp chamber. These tubules are more or less tortuous in shape, as they pass from the layer of odontoblastic cells to the dento-enamel junction, where they communicate with each other, forming more or less of a network which accounts for the sensitiveness at the dento-enamel junction, which is much more sensitive than the dentin situated between the dento-enamel junction and the dental pulp. Each dental tubule contains a protoplasmic process which is given off by the odontoblast. Some authors call these protoplasmic processes Tomes' fibers.

Romer claims that a square millimeter of dentin contains 31,500 dentinal tubules. The layer of cells called odontoblasts is situated exterior to the dental pulp, forming a continuous sheath.

The Dentinal Fibers (Tomes' Fibers) or Protoplasmic Processes.—When the dentin is cut by a dental bur or chisel and is mutilated, there is a certain amount of sensation transmitted over the dentinal fibers to the odontoblasts, then over the afferent nerve path to the brain. If the dentin is perfectly sound and healthy, little pain is caused by the severing of the dental tubules, but when the fibers have become irritated, such as is caused by caries, the cutting of the dentin will cause the patient excruciating pain. If the dentinal fibers or protoplasmic processes contained within the dentinal tubules are irritated, and especially when they are irritated at the dento-enamel junction, the irritation causes painful afferent impulses, usually severe in character.

Linderer speaks of the protoplasmic processes as "juice fibers," or an organic substance which carries on metabolic changes in the dentin. Prinz in his textbook quotes Gysi's theory of the hypersensation of dentin as follows:

"The dentinal tubules have no nerves, but an organic substance which carries on metabolic changes in the dentin. The sensitiveness of dentin is, therefore, not a physiological process, and the physiological sensitiveness of a tooth is conceived only by means of the nerve of the part and of the cementum. Sensitiveness of dentin results from pressure, tension, or torsion upon the organic substance of the tubules, which in turn convey the disturbance to the odontoblasts and then to the nerve endings of the pulp proper. The contents of the tubules are aqueous in nature, and as water can not be compressed to any appreciable extent, the organic substance confined in the tubules represents a fixed, although comparatively easy mobile column. (Water filled in a tube one meter in length can be compressed only about 1/1000th mm.) As there are no nerves in the dentin, the sensitiveness can not be overcome by an anesthetic, unless this anesthetic can be conveyed through the organic substance into the pulp proper. Substances which coagulate albumin, as phenol, silver nitrate or zinc chlorid, destroy the albumin molecule with which they come in contact, but their deeper action is more or less prevented by their own coagulum. If, however, drugs are applied which are noncoagulants, and are absorbed by the organic contents of the tubules and are thus conveyed to the pulp, they may act as direct protoplasm poisons, depending on their individual pharmacological action– destroying the vitality of the pulp completely, like arsenic trioxid, or paralyzing the nerve tissue, like cocain."

The Formation of Secondary Dentin.—The formation of secondary dentin is a physiological and not a pathological process. It is nature's way of protecting the dental pulp from irritation, and if the irritation is not too pronounced or great in character, secondary dentin will be deposited around and over the dental pulp to protect it from irritation, such as caries. The formation of secondary dentin many times is caused by placing a metallic filling too near the dental pulp which will cause continual irritation by thermal changes. A layer of secondary dentin is formed to protect the dental pulp from these abnormal thermal changes. Secondary dentin is also produced many times through grinding the enamel of a tooth, thereby exposing the dento-enamel junction which causes irritation. The formation of the secondary dentin is a physiological process taking place as the patient advances in years and the teeth wear down. Secondary dentin does not contain a normal protoplasmic process, such as is contained in the dentin formed during the embryological formation. It is very dense and considerable difficulty is encountered in forcing a local anesthetic solution through it, in order to reach the dental pulp. In fact, many times it is impossible.

General Factors Concerning All Forms of Pressure Anesthesia.—When a solution of procain or cocain is placed in contact with the protoplasmic fibers which are contained in the dentin, it is absorbed very slowly. By the laws governing osmosis it is a proved fact that a vehicle composed of Ringer's solution aids a great deal in the absorption of the anesthetic. It is impossible to produce anesthesia by contact unless the anesthetic medicament is in the form of a solution and is placed in contact with the dentin. The rapidity and extent with which anesthesia is produced depends upon the pressure applied and allowing sufficient time for the solution to produce anesthesia.

As stated, the laws of osmosis enter into the absorption and penetration of the anesthetic solution by the protoplasmic substances contained in the dentin. This being true, dehydration of the dentin, as accomplished by applying alcohol to the part and then drying with a hot air syringe, will very markedly increase endosmosis and will produce a much more rapid and a deeper anesthesia. It must be remembered that with healthy dentin considerable pressure must be exerted upon the solution to produce anesthesia, while if the same amount of pressure is applied to the anesthetic solution with dentin which is carious, a considerable amount of the solution will be forced through it. The reason for this is that the carious dentin has lost a large part of its inorganic material, the remaining portion being composed of an elastic spongy matrix. Before the anesthetic solution is applied to the cavity, the dentin, which has been affected by caries, should be treated with chloroform or acetone to dissolve the fatty deposits. Following the application of chloroform, apply phenol which will help to sterilize; then dehydrate by alcohol and hot air. If the principal part of the carious dentin has been carefully removed by the excavator, the cavity treated as directed, and the anesthetic solution applied on a pledget of cotton, as described under technic, then covered with unvulcanized rubber, with gentle, steady pressure exerted upon it, good results will be secured in most cases, inasmuch as the solution will pass through the dentin into the pulp.

Technic for Anesthetizing a Partially Exposed Pulp by Pressure Anesthesia.—The overhanging enamel should be removed and the greater part of the debris contained in the cavity carefully excavated, after which the rubber dam is applied. Remove as much of the decayed dentin as possible, after which apply a small amount of chloroform on a pledget of cotton to the cavity walls, which will dissolve the organic material present. Follow this with an application of phenol, which will assist materially in sterilizing the surface of the remaining decayed dentin, allowing the pledget of cotton, saturated with phenol, to remain in the cavity for several minutes. The phenol treatment is now followed with the application of a new pledget of cotton saturated with alcohol and by dehydration with hot air. After the cavity has been thoroughly dried with alcohol and hot air, saturate a small pledget of cotton with a 20 per cent procain solution. (See page 651.) The pledget of cotton containing the anesthetic is placed in the cavity, over which a larger piece of cotton, more or less flattened, is placed. The cotton is covered with a suitable sized piece of unvulcanized rubber, being very careful to see that the rubber is in contact with the margins of the cavity. Then with a suitable instrument, such as beaver-tailed or ball burnisher, gentle, continued pressure is exerted upon the unvulcanized rubber. (See Fig. 477.) Very little pressure should be used at the start, so as not to cause pain to the patient. However, gentle pressure should be exerted for a few minutes, after which the pressure is gradually increased. Pressure should be continued for four or five minutes, after which the rubber and cotton are carefully removed, and with a small sharp bur the dentin is tested. If sensation is present, repeat the process as long and as often as is necessary. Loeffler in his article, published in the *Dental Digest* in 1908 advised taking a small short piece of orangewood and shaping it to fit the cavity, and placing it upon the unvulcanized rubber, then having the patient bring his teeth down upon the stick, gradually increasing the force. In many cases this can be done to great advantage, and the patient can regulate the pressure with much less discomfort to himself. Loeffler in the *Dental Summary*, 1906, describes the attachments he designed, which vary in size and shape, to be used on a syringe for producing pressure anesthesia.

He states: "The results obtained in a number of almost hopeless cases have been very gratifying, to say the least."

His technic is to take one of the attachments, which has been adapted to the tooth and cavity, and cement it into place over the pulp. After the special attachment is cemented into place, the anesthetic solution is injected into the pulp chamber under slow continuous pressure with a hypodermic syringe. In the *Dental Register*, 1904, Miller describes his technic as follows:

"After excavating the cavity as far as convenient and smoothing the borders of it, take an impression in modeling compound, endeavoring to get the margin of the cavity thoroughly well defined; put a few threads of cotton into the cavity and saturate them thoroughly with a 5 to 10 per cent solution of cocain, cover this with a small bit of rubber dam, and then press the compound impression down upon it. We obtain thereby a perfect closure of the margin, so that the liquid can not escape, and one can then exert pressure with the thumb sufficient to press the solution into the dentin."

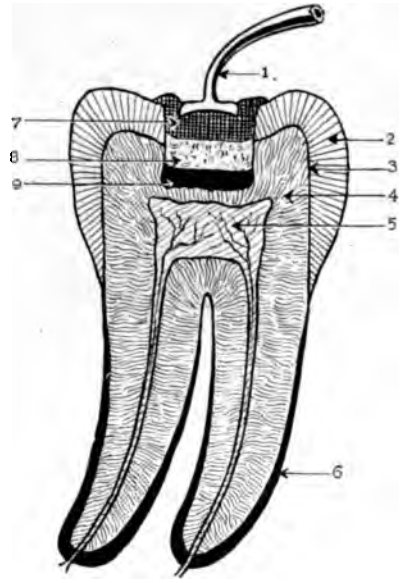


Fig. 477.—Cross section of molar and method of producing pressure anesthesia.

1, Properly shaped instrument for applying pressure; 2, enamel; 3, dento-enamel junction; 4, dentin; 5, pulp chamber; 6, cementum; 7, unvulcanized rubber; 8, cotton; 9, anesthetic.

Anesthetizing the Dental Pulp, Which is Covered by Secondary Dentin or a Thick Layer of Healthy Dentin.—There are two methods employed for anesthetizing the dental pulp which is covered by a thick layer of healthy dentin. or a layer of secondary dentin. The first method is the same as that which has been described, with the exception that after the anesthetic solution has been inserted into the cavity on a pledget of cotton and pressure exerted upon it, the rubber and cotton are removed, and with a small, sharp bur, a small amount of dentin is cut away until the patient experiences slight pain, when the technic is repeated. This process is repeated as often as necessary until the pulp is exposed, and anesthesia is complete enough for pulp removal. However, in some cases, in which there is a very thick layer of secondary dentin covering the pulp, failure may result in producing anesthesia by this method, for the reason that the secondary dentin does not contain the dentinal tubules which permit the anesthetic solution to permeate it and reach the odontoblasts and dental pulp.

The second method of anesthetizing the dental pulp, which is covered by a thick layer of healthy dentin or secondary dentin, is the use of the high pressure syringe which has been advocated by some operators.

Producing Anesthesia by the High Pressure Method.—A number of articles have appeared in journals in the past on high pressure anesthesia, and among those who have advocated this method of anesthetizing the dental pulp are C. G. Meyers, R. A. Ingalls, W. T. Jackman, J. B. Sapp, and others. It is true that soon after the introduction of the high pressure syringe, and the technic of its use was presented to the profession, it had a number of strong advocates, but within recent years it has almost been abandoned in favor of the deep block and other methods of producing anesthesia.

General Considerations of High Pressure Anesthesia

Definition.—High pressure anesthesia is the method of rendering the dental pulp and immediate structures insensible to pain, and is accomplished by forcing an anesthetic solution under high pressure through the substance of the tooth. This is accomplished by a special syringe under which the anesthetic solution is subjected to an enormous pressure. (See Fig. 478.)

In reviewing the literature on this subject, the author has found that there has been a difference of opinion with reference to the feasibility of forcing the anesthetic solution through healthy dentin without causing injury to the tooth. Those who have advocated this form of anesthesia state that after years of constant use of the high pressure syringe, there has been no injury of the dental pulp or tooth, while others say that their results have been very unsatisfactory. Prinz states that it is impossible to force a liquid through healthy dentin by a mechanical device without injury to the tooth itself. So it seems that this question has not been definitely settled. This method is not very popular at the present time and is being displaced by the more efficient ones, such as the deep block, intraosseous and infiltration methods.

Walkhoff made many experiments in attempting to force solutions which were colored into teeth that had recently been removed. He subjected the colored solution to six atmospheres of pressure for one-half hour, then opened the teeth and found that the colored solution had not permeated the dental pulp. The experiments performed by him were not conclusive evidence that it was impossible to force the anesthetic solution through healthy dentin, for the reason that greater pressure is exerted upon the solution by the high pressure syringe than by six atmospheres of pressure as employed by him. Tests by several others have also proved that the dental pulp can be anesthetized in most cases by injecting the solution through the tooth substance with the high pressure syringe, as practiced in the past by many members of the profession.

Contraindications for Pressure Anesthesia.—Producing anesthesia of the dental pulp through the application of the local anesthetic by means of vulcanized rubber and slow gentle pressure, or applying the solution with a high pressure syringe, is contraindicated in the following cases:

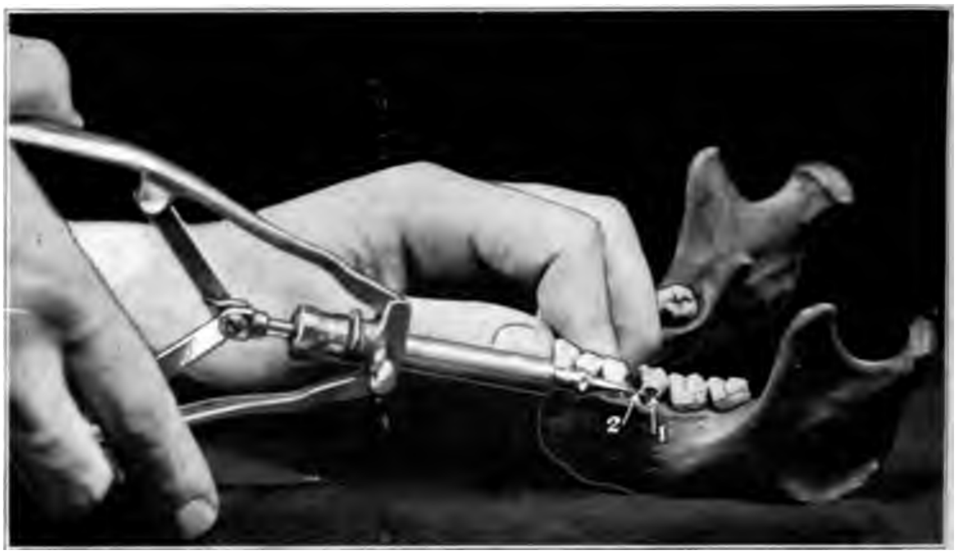


Fig. 578.—The Meyers high pressure syringe.
1, Cavity [illegible]; 2, point of needle located in pit near cavity.

1. With teeth that are eroded, worn or abraded, which have caused an extensive deposit of secondary dentin.

2. With teeth that possess pulp nodules or are badly calcified.

3. With teeth having leaky fillings, or in which the tubules are closed either by pathologic or metallic processes.

4. It is difficult to secure anesthesia by the pressure method in teeth of patients of advanced years, or with those who are addicted to tobacco chewing.

5. Pressure anesthesia in any form is contraindicated in cases of pericementitis, or an inflamed pulp.

When secondary dentin is examined under the microscope, in most cases, either the tubules are very tortuous or are entirely absent. When the tubules were present, Reigh found that they had no connection with the odontoblasts. With this fact before us, we can at once see the fallacy of attempting to force the anesthetic solution through a substance that is impervious.

Time to Wait for Anesthesia by the Pressure Method.—Hertwig states: "The protoplasm transmits irritation primarily, and absorbed material secondarily." If this is the case, when the anesthetic solution is applied to the surface of dentin, it must pass the entire distance of the protoplasmic fiber before the dental pulp is reached, for a certain amount of time must elapse to allow the anesthetic to penetrate the dentinal tubules and produce anesthesia of the pulp. The time to wait for anesthesia depends upon the thickness of the dentin, the composition of the dentin, the presence of abnormal conditions, such as pulp nodules, secondary dentin, and the amount of solution which passes through the dentin in the region of the dental pulp. Many failures in the use of pressure anesthesia can be attributed to the operator attempting to operate too quickly after the anesthetic has been applied. No doubt more failures can be attributed to this one cause than to any other one factor. When the operator employs pressure anesthesia, he should always remember the histology and pathology of the tissues through which he is forcing the anesthetic, and allow ample time for the solution to permeate the structures before attempting to operate. In case deep anesthesia has not been secured the first time, a small amount of dentin should be cut away with a sharp bur and the anesthetic solution reapplied to the cavity. This process should be repeated as often as is necessary until the dental pulp is anesthetized. After an exposure of the pulp has been made, it should be thoroughly anesthetized by reapplying the pledget of cotton containing the anesthetic, and gentle pressure used to thoroughly anesthetize it before inserting a broach for its removal.

The High Pressure Syringe.—Several high pressure syringes have been designed by various operators, so the anesthetizing solution may be subjected to enormous pressure. The principle is to force the solution through the dentin at a point near the cavity to anesthetize the dental pulp. The syringes were designed in such a way as to subject the solution to high pressure, which is accomplished through the medium of long handles attached to the plunger. (See Fig. 478.) The syringe is equipped with a special needle to make a perfect contact between the needle point and tooth structure.

Technic of Producing Anesthesia by the High Pressure Method.—A brief description of the technic for obtunding a tooth for cavity preparation, pulp removal or other operations on the teeth will now be given.

The first step in the technic is to desensitize the gum tissue at the gingival margin, by either injecting the solution following the peridental method or through the application of a 20 per cent solution of procain. The cotton upon which the anesthetic is contained should be in contact with the gingival margin for five minutes. The object of this procedure is to produce anesthesia of the gum tissue near the gingival margin, in order that the application of the rubber dam clamp or ligature will not cause pain or discomfort to the patient. The overhanging enamel margins of the cavity and some of the decayed dentin should be removed, following which the rubber dam should be carefully adjusted. Let us take, for example, a lower left first molar which contains two cavities, an occlusal and a buccal cavity. (See Fig. 478.) Take a No. 3 round bur and make a pit on either the mesial or distal part of the buccal cavity, or better still, make it below the cavity. Following the use of the No. 3 round bur, slightly deepen the cavity with the one-half round bur. Great care should be exercised not to penetrate the enamel and allow the bur to enter the dentin, thus causing unnecessary pain. It is well to leave one-fourth the thickness of enamel between the bottom of the pit and the dento-enamel junction during the first application of the solution. The syringe is equipped with long handles and a locking device between the handles. When complete contact is established, the handles remain locked, which relieves the hand from the pressure that is required.

The solution used by the high pressure method has been a 2 per cent cocain hydrochlorid, but the author advises instead a 10 per cent procain solution. The syringe is filled and held as illustrated in Fig. 478. The operator should stand behind and to the right of the patient. The left arm is passed around the patient's head and the left hand is used to support the mandible. A convenient method for supporting the jaw is to place the second, third and fourth fingers of the left hand beneath the lower jaw near the median line, and then allow the index finger to press against the tooth to be operated upon, which aids greatly in counterpressure. The point of the special needle, which has been mounted on the syringe, is carefully placed in the pit which has been prepared in the tooth and gentle pressure is exerted upon the handles. If poor contact exists between the needle point and tooth structure, the solution will very likely escape at the imperfect joint. It must be borne in mind that anesthesia of the tooth is dependent upon the amount of solution that actually passes through the tooth structure and the time given for the solution to act.

At this time considerable care must be given to the remainder of the technic to secure the best results. The operator must be familiar with the technic, for if guess work is used, his efforts will be a failure. Thirty seconds should elapse after the first application of the syringe, that is, when perfect contact is obtained. It will take this length of time, when the solution is subjected to pressure, to force it through the remaining thin layer of enamel and a short distance into the dentin at the dento-enamel junction. After giving the solution subjected to pressure, thirty seconds to penetrate the thin layer of remaining enamel, anesthesia of the dento-enamel junction is secured in most cases. Then the pit is again deepened with a No. ½ round bur, and the needle is placed in the newly made pit and great care exercised in obtaining perfect contact. Two minutes should elapse after subjecting the solution to high pressure. If the contact between the tooth structure and the needle point has been perfect, there being no leakage, and the handle closed as nearly as possible, in many cases the dental pulp may be anesthetized so that sensitive cavities may be prepared or the pulp removed. However, if the patient experiences sensation, the No. ½ round bur may be used again, deepening the pit, and the same procedure repeated.

Failures from High Pressure Method.—The greatest drawback to this method is the delay necessary for the solution to penetrate the dentin and reach the dental pulp. The operator who is in a hurry or careless will stamp the method as entirely inadequate and inferior, and probably cast it aside.

If the high pressure method is used for the removal of the pulp, it is necessary that twice as much time be allowed as for preparing a hypersensitive cavity. This rule does not hold in all cases, because the pulp which is being anesthetized may be in a state of congestion, and if the congestion has reached the stage of stasis, it will be impossible to anesthetize it by either form of pressure anesthesia. However, a congested pulp can be completely blocked by the "Deep Block Method."

Precautions and Contraindications for the High Pressure Method.—1. If the dental pulp is to be removed, twice as much time should elapse in allowing the solution to reach the pulp as for cavity preparation.

2. If the pulp is in a state of congestion and has reached the stage of stasis, it will be impossible to anesthetize it by the pressure method.

3. If secondary dentin has formed over the pulp at the point where the pit is made, and the solution injected, very little or no anesthesia will be produced. However, the pulp may be reached by making a second pit at a different location.

4. In the aged patient, the teeth are extremely sensitive and the dentinal tubuli are almost entirely obliterated, which may cause failure by the high pressure method.

5. Care should be taken not to force too much solution into the dental pulp if a cavity is to be prepared and the pulp not removed, with a view to avoiding death of the pulp by strangulation.

6. The pit should be made, and the solution injected at some surface point near the margin of the cavity.

Disadvantages of Pressure Anesthesia, Including All Forms.—It matters not whether the anesthetic solution is subjected to pressure either by the slow, gentle, continuous pressure, as applied to the cavity by a pledget of cotton containing the solution and covered by unvulcanized rubber, or the injecting of the solution by the high pressure syringe, there are several disadvantages.

These are:

1. If cocain is employed as the anesthetic in pressure anesthesia, it should be borne in mind that it is a strong protoplasmic poison, and paralyzes all cells with which it comes in contact. It must also be remembered that many patients are hypersusceptible or possess an idiosyncrasy for this toxic drug, and when

It is applied to a carious cavity and pressure exerted, forcing it into the dental pulp, a sufficient quantity may enter the circulation and produce toxic symptoms. The writer recalls three cases in which general toxic symptoms were manifested when cocain was employed by the pressure method but he does not recall such a condition having occurred with procain.

2. It makes no difference whether the anesthetic used is cocain or procain, as far as the carrying of toxins or ptomaines into the dental pulp are concerned. It is impossible to remove all of the pathologic dentin with an excavator or bur, if the cavity is sensitive, before the pressure method of anesthesia is utilized. Therefore the passage of the solution under pressure through pathologic dentin has, in the author's opinion, been the cause of carrying infected material and bacteria into the dental pulp, where it has entered the circulation and passed through the apex of the root of the tooth, and undoubtedly has been the cause of infecting the delicate peridental membrane in the region of the root apex, and the results are later revealed by the radiogram.

3. When all the factors mentioned are considered for producing pressure anesthesia by both methods, and the possible postoperative complications duly weighed, the deep block method, or some other local form of anesthesia, is preferable.

PULP EXTIRPATION AND THE FILLING OF ROOT CANALS

In some cases, when the operator desires to extirpate a pulp following a deep block injection, it is found upon entering the pulp chamber that the dental pulp still retains slight sensibility, this may be due to a pathological condition, or to the fact that sufficient time has not elapsed for the solution to anesthetize the nerve branch at the point of injection. It is a well-known fact that a dental pulp may be removed painlessly following a deep block injection, if sufficient time has been allowed for anesthesia to take place.

It is not considered good practice to fill the root canal immediately following pulp extirpation, for it is practically impossible to remove all of the dental pulp from the canal. The pulp is attached very closely to the walls of the canal and it is difficult to remove all the fine shreds, which should always be removed, and the root canals cleansed and sterilized before applying a permanent filling. Hemorrhage must always be considered, for in most cases, following pulp extirpation under a local anesthetic, the root canals will be filled with serum or blood, which is difficult to arrest, and even if the hemorrhage is controlled, there will be a pronounced edematous area surrounding the root apex. Several days are required for the area to become normal and in many cases pericementitis may develop which results in postoperative soreness and discomfort to the patient.

Pulp removal by the arsenic method is rapidly being replaced by the block method, and there is no question but that local anesthesia is far superior to the arsenical method. The removal of all pulp debris must be practiced to avoid the possibility of future pathologic complications which occur if every portion of the pulp is not removed, and the root canals thoroughly cleansed and sterilized before applying the permanent root canal filling. It is a known fact that the action of the arsenic, which has been employed for the devitalization of the dental pulp, has in many cases extended beyond the apex of the tooth and has caused tissue changes even to the extent of necrosis in the delicate tissues around the root apex. Such damage to the tissues as this invites future complications, such as postoperative soreness of the tooth, granulomas and focal infections.

When the operator finds it necessary to fill the root canal immediately following pulp extirpation by local anesthesia, he should by all means arrest the hemorrhage and attempt to remove all traces of pulp debris, clotted blood, and thoroughly sterilize the canals by cauterization. The author does not advise immediate root filling, as it is far better to place a soothing dressing in the root canals and pulp chamber, seal the cavity, and fill the canals at another sitting.

CIRCULAR OR REGIONAL ANESTHESIA (BY EXTRAORAL METHOD)

This is a method of producing anesthesia of a circumscribed area by injecting the solution around the region to be operated upon, which interrupts the conductivity of all nerve branches.

It was Hackenbruch who first described the method of circular anesthesia. He blocked a circumscribed area enclosing the operative field with the anesthetizing solution which anesthetized all sensory nerves leaving the operative field. He employed a solution of 5 and 10 per cent cocain. This method, at the time it was first introduced, was limited to the extremities, such as the removal of fingers and toes. The solution was injected beneath the skin of the finger or toe at the base of its ligation. Profound anesthesia of the part was quickly produced on account of the solution infiltrating through the tissues to the nerve branches which supplied the part. This is really a method of regional anesthesia which has acquired the name of circular anesthesia, due to the manner in which the solution is injected. (See Fig. 473.) The solution is injected in a circular fashion around and beneath the operative field which blocks the conductivity of all sensory nerve branches leaving the area. The solution should be injected 2 or 3 cm. outside the margin of the operative area for two reasons. *First,* the nerves at this point are in most cases free from inflammation; *second,* it will eliminate pain while a larger sized needle is being inserted beneath the operative area to block the nerves situated deeper in the tissue.

This is a useful method but can be employed only in certain cases. If it is possible to inject the solution around and beneath the operative field, successful results will be obtained. There may be some difficulty in having the solution reach the nerve branches which enter the operative field from beneath. For operations upon the face or head which come under the observation of the oral surgeon in which this method can be employed, it will be found that the extraoral or intraoral deep injections are in most cases superior. This method has its greatest value and is applicable for anesthetizing an operative field on the skin or subcutaneous tissues. For example, the removal of foreign bodies, tumors, plastic operations, treatment of cysts, furuncles, carbuncles, etc. The method blocks or causes a disconnection of the area of operation from the surrounding area; that is, if the nerves which enter the area from beneath the operative field are not very large or too numerous.

The needle is inserted beneath the skin and from one to two mils of solution is slowly injected. After a sufficient length of time has elapsed the needle is again inserted in the margin of the wheal which is anesthetized, and the solution injected a second time. This is repeated until the solution has been injected around the entire operative field. (See Fig. 473.) A few minutes after the area has been surrounded by injections, it will be found that the outer part is first to yield to the effects of the anesthetic. The solution readily diffuses and penetrates the tissue within the circle, thereby anesthetizing the different nerve branches. After the solution has been injected in a circular manner, a long needle is passed through the anesthetized zone to the base of the operative area, and several mils of the solution are injected. If the nerves which enter below the field of operation are of large diameter or deeply located, it may be very difficult to completely block them. The long needle should be inserted in at least three directions so the solution will be distributed over considerable area. An exception to this rule is where the subcutaneous nerves pass to the deeper tissues through the fascia, thus supplying periosteum and bone. A good example of this is the scalp. If the area of operation is upon some part of the body which is supplied with large nerve branches, they can be blocked at various locations where they can be reached.

One great advantage of this method is that the inflamed tissues are not injected with the solution, but the solution is injected into normal tissue and is allowed to infiltrate into the inflamed area. It is well not to employ a solution of low percentage if this method is used. The author employs in most cases a solution of 2 per cent procain plus 1/25,000 suprarenin in a Ringer vehicle. Care should be taken not to inject the solution into an inflamed or abscessed area, but into the healthy surrounding tissue.

BLOCKING THE SOFT TISSUES WITHIN THE ORAL CAVITY, BY THE CIRCULAR OR REGIONAL METHOD

In an operation upon the soft tissues located within the oral cavity, as. for example, the removal of an epulis, ranula, or any benign growth, the part can in most cases be thoroughly anesthetized by the circular or regional method. unless the operative area is very large or involves the bone, then this method should not be employed, but the blocking of the deep nerve trunks should be done instead. If for any reason the operator thinks it is advisable not to make the deep block injections of the nerves supplying the operative area, this method may be employed, but it will be found that, in many cases, the deep block method is preferred.

The technic of the circular or region method for operations within the oral cavity is as follows: Take, for example, any new growth, located at some point in the anterior two-thirds of the floor of the mouth. Needle No. 4, 30 mm. in length, and 25 gauge, is employed. The needle is inserted at the extreme margin of the operative zone, and one mil of the solution is slowly injected. The solution will produce a circular area of anesthesia (see Fig. 473). The needle is now withdrawn and is inserted again within the margin of the tissue which has been anesthetized by the first injection. This technic is repeated as often as is necessary for the purpose of injecting the solution entirely around or encircling the operative area. After as many injections have been made as are necessary to encircle the area, then, if possible, insert a long, fine needle, 40 mm. in length, beneath the operative zone and inject one mil of solution. The needle is now withdrawn, without taking it out of the tissue, and its direction slightly changed mesially, and another mil of the solution injected. The needle is again retracted but not removed, and reinserted laterally to the first and second injections, and another mil of solution is deposited. These last injections help considerably in blocking any nerve supply which may enter the operative field from beneath. By injecting the solution, as above described, around the operative area, it does not necessitate the insertion of the needle in the pathological tissue to be operated on, but instead, the solution is deposited in the healthy tissue around the operative area, and the solution will infiltrate through the tissues, thus producing profound anesthesia of the entire area. (See Fig. 473.)

In case the operation is for the removal of a tumor or cyst of considerable size, located on the tongue, floor of the mouth, or gum tissue, it is better to block the right and left lingual nerves at a point 1 cm. above the occlusal plane of the lower teeth, as described on page 570. In addition to the lingual block injection, inject some solution by the infiltration method in the region of the posterior part of the mouth and do not depend entirely on the circular or regional method. The circular or regional method of anesthesia is of value in blocking the gum tissue and periosteum of the hard palate, in such cases as the removal of a malposed tooth, which may be located in the roof of the mouth. The solution should be injected slowly beneath the periosteum, following the same technic as described above. If the tooth is deeply seated, a portion of the outer nerve loop must be blocked, this depending upon the location of the operation.

SCHLEICH'S INFILTRATION METHOD

Schleich deserves much credit for his research work on the infiltration method, as he was the first to call attention to it. With this method the operative area is infiltrated with a dilute anesthetizing solution so as to cause a marked swelling of the part. This method is employed mostly for superficial operations upon various parts of the body. The skin in the immediate vicinity of the incision is first injected, and after a few moments have elapsed, giving sufficient time for anesthesia to take place, the next step is taken, which is to infiltrate the subcutaneous tissue, and after a few minutes, the deeper layers of the subcutaneous tissue are injected. This method, as devised by Schleich, makes it possible to use very dilute anesthetizing solutions. When he first introduced the method he employed three solutions which varied in amount of cocain; first, a 0.2 per cent; second, a 0.1 per cent; and third, 0.01 per cent. In each one of these cocain solutions 0.2 per cent sodium chlorid was used. Within recent years Schleich has substituted alypin for a part of the cocain he formerly used. The author does not advise cocain solutions to be used promiscuously, and he sees no reason why cocain should be employed in either oral, plastic, or dental surgery, because we have other drugs which are far less toxic.

Schleich first employed and advocated three solutions of the following formula:

No. 1		No. 2		No. 3	
Cocainae	0.2	Cocainae	0.1	Cocainae	0.01
Sodii chloridi	0.2	Sodii chloridi	0.2	Sodii chloridi	0.2
Morphinae sulphatis	0.02	Morphinae sulphatis	0.02	Morphinae sulphatis	0.005
Aquæ destillatæ	100.0	Aquæ distillatæ	100.0	Aquæ destillatæ	100.0

Schleich used solution No. 1 for the tissue which was in an inflamed and sensitive condition; also for operations which were superficial, involving the skin.

Solution No. 2 was used for tissues which were less sensitive, and yet superficially located.

Solution No. 3 was employed for infiltrating the deep tissues which were practically without sensation, and where a large quantity of the solution was to be injected. Morphin was added because it was thought that it possessed some local anesthetic properties, but the truth of the matter is that instead of its having a local anesthetic action, it had a general effect upon the patient and soon followed the local anesthetic action of the cocain, which, of course, would relieve any after-pain which might accompany the operation. Schleich also depended upon a hypotonic sodium chlorid solution to bring about a certain amount of anesthesia, which is not advisable. It is not in accordance with the principles of good practice to add morphin to a local anesthetic solution, because it is very difficult to determine just how much of the morphin will be absorbed; also that its local anesthetic action is wanting. If it is necessary to give morphin, it is much better to administer it hypodermically from three-quarters to one hour before the operation.

The solutions employed by Schleich at the present time are as follows:

Solution 1		Solution 2		Solution 3	
Cocain	0.1	Cocain	0.05	Cocain	0.01
Alypin	0.1	Alypin	0.05	Alypin	0.01
Sodium chlorid	0.2	Sodium chlorid	0.2	Sodium chlorid	0.2
Aq. dest.	100.0	Aq. dest.	100.0	Aq. dest.	100.0

Schleich was under the impression that a 0.2 per cent solution of sodium chlorid produced slight anesthesia. If this is the case, then a 0.2 per cent salt solution must be listed as an anesthetic. However, this is not practical because it is a hypotonic solution and does not conform to the laws of physiologic solutions. A second factor is the edema, consequent ischemia and pressure from the solution upon the sensory nerve fibers. The third factor is the difference in temperature between the anesthetizing solution and the blood. It was injected at room temperature, or at a temperature even lower.

In summing up Schleich's method of infiltration anesthesia, it is one dependent upon physiologic principles, inasmuch as he says cocain which is in the solution fulfills only a secondary role, the main function of the cocain being to eliminate the pain which is caused by the actual infiltration of the solution into the tissues, also to block the hyperesthetic state of the inflamed tissues. If a 0.2 per cent salt solution, containing no anesthetic, is injected into tissues free from inflammation, the results are unsatisfactory. The author has used Schleich's method in a number of cases with limited success. The tissues injected were practically free from inflammation, but failures were met where it was employed upon inflamed tissues.

Braun does not agree with Schleich's views in any way and challenges the value of a 0.2 per cent sodium chlorid solution. It is known that a salt solution will produce very slight anesthesia when injected, and the anesthesia in nearly all cases follows a period wherein the patient experiences pain which is caused by the injection, and it has also been proved that the pain caused is much less than when distilled water is injected. The anesthesia produced by the salt solution is of shorter duration than that produced through the medium of distilled water. Braun, however, admits that a transient partial anesthesia may be induced by the injection of a 0.2 per cent sodium chlorid solution, and he also maintains that the small amount of cocain contained in Schleich's solutions is of sufficient quantity to enormously surpass Schleich's so-called physiological anesthesia.

The question of injecting a .2 per cent salt solution into the tissues does not seem to be good practice, for the reason that distilled water injected into the tissues acts as a powerful tissue irritant, and a 0.2 per cent solution, which is not isotonic, is bound to possess irritating properties. ***Experimental work has proved that a physiologic Ringer solution containing sodium, calcium, and potassium chlorids, is entirely void of any irritating properties,*** *and can be injected into the tissues without causing irritation or postoperative pain.* There is no question but that the ischemia which is produced by infiltrating the tissues has some effect upon the sensory nerve endings in the production of anesthesia. The area infiltrated being in an ischemic condition furnishes an ideal state to prevent the absorption of the solution injected which contains a small amount of cocain and alypin. The ischemia may act in the same manner as adrenalin, that is, in preventing absorption of the solution, also producing partial anesthesia of the nerve endings. As the solution injected is of a lower temperature than the tissues, it also tends to have some anesthetic effect.

When we analyze Schleich's theories of producing anesthesia by his method, they resolve themselves into the following factors:

1. By the solution being injected at a temperature lower than that of the body.
2. From pressure caused by the solution upon the sensory nerve endings.
3. From the action of the anesthetic.
4. Ischemia of the tissues produced by the solution.

There has been considerable controversy as to the practicability of Schleich's method, and many operators have discarded it entirely, while others claim they obtain very good results from its use. However, nearly all operators have a different conception of producing anesthesia and rely upon the anesthetic action of the drug contained in the solution to produce the desired anesthetic effect; they also depend upon the vaso-constricting power of suprarenin to maintain anesthesia for an indefinite period.

The Disadvantages of Schleich's Method.—

1. Considerable time is required before the first incision can be made without causing pain.

2. It is always necessary to infiltrate the deep tissues after the first incision has been made, and then wait a considerable time for anesthesia to develop.

3. If the operation should involve deep tissues, it is impossible to anesthetize nerve branches of considerable size with Schleich's solution.

4. It is sometimes impossible to distinguish between inflamed and normal tissues.

5. The uncertainty of producing anesthesia.

Schleich's technic for anesthetizing an area of inflamed tissue is to infiltrate around the focus and gradually bring the injections closer and closer to the operative area until the actual pathological tissue is saturated with the injecting solution. The writer can see no difference between this method and that of Hackenbruch's regional or circular anesthesia. Hackenbruch's method is a subdivision of block anesthesia, and in the author's opinion it is properly classified because the small and large nerve branches entering the area of operation are blocked. We are quite aware of the fact that when normal tissues are infiltrated with a large quantity of anesthetizing solution, and especially if it is injected in the tissue under pressure, a rapid diffusion takes place throughout the entire surrounding area. Therefore, when the solution is injected under pressure around the operative area, which is in a highly inflamed state, it is self-evident that a quantity of the solution will infiltrate the area to be operated. In most cases, if the circular injections have been properly made and the operation be a superficial one, there is really no need for inserting the needle into the inflamed tissue as recommended by Schleich. Since the newer anesthetics have been discovered and large quantities of comparatively weak solutions, such as procain can be injected, it has increased the value of circular or regional anesthesia, and has greatly improved the method. Therefore, if the operation is upon the surface of the body, solutions can now be injected, using the regional or circular method, and satisfactory results achieved.

CHAPTER XXIX

SURGERY AND ANESTHESIA OF THE MAXILLARY SINUS

Diseases of the tissues involving the maxillary sinus are very common and patients for this operation fall into the hands of the oral surgeon more frequently than the general surgeon.

The writer, therefore, will not only endeavor to describe the blocking for each route of operating, but will also give the diagnosis, the technic of the various operations and the postoperative treatment.

Anatomy of the Maxillary Sinus.—The maxillary sinus (antrum of Highmore) is situated within the body of the superior maxillary bone, and is pyramidal in shape. Its base is towards the nasal cavity and communicates with the middle meatus of the nose by an aperture called the ostium maxillare, which is very small, admitting only a small probe. (See Fig. 479.) This opening is partly closed by the articulation of the ethmoidal process of the inferior turbinate, and the unciform process of the ethmoid, also by the maxillary process of the palate bone, with a distinct fissure located in the superior maxillary bone. In addition to this, the maxillary process of the inferior turbinate bone is situated along the lower edge of the aperture. The opening is slit-like, and is situated about the center of the middle meatus, just posterior to the hiatus semilunaris, and is approximately 25 mm. above the floor of the nose. Its apex and summit extend laterally into the roots of the zygomatic process. The sinus is bounded laterally and above by thin walls of bone which are located on the anterior lateral surface of the body of the superior maxillary bone. The inferior part or floor of the sinus is situated just above the alveolar process, and in many individuals the apices of the roots of the upper second bicuspid and first molar, and sometimes the first bicuspid and second molar, penetrate the floor of the antrum by extending through the thin bone which is located at this point. (See Fig. 480.) The corners and angles of the sinus often present narrow ridges or septa of bone, and in many subjects a groove in which is located blood vessels. Also in some cases nerve tissue is found along the floor of the sinus just superior to the apices of the roots of the teeth which are situated directly beneath the antrum. The maxillary sinus lies beneath the orbit and to the lateral side of the nasal fossæ. The walls are extremely thin, and it is for this reason that tumors, exudate or pus under pressure produce bulging either forward, causing a protrusion of the cheek, or upward, causing ocular disturbances. The infraorbital nerve, which is the continuation of the second division of the fifth nerve, is located just above the roof of the sinus, it being separated from the cavity of the sinus by a very thin shell of bone. Great care should be taken while performing the radical operation for empyema of the antrum, in curetting the superior part of the sinus, so that the infraorbital nerve will not be injured. (See Figs. 49, 51, 68, 70, 71, 480 and 481.) The posterior wall forming the sinus presents for examination in most cases, the posterior dental canal or groove. The anterior, middle and posterior superior dental nerves, which branch from the infraorbital nerve, supply the upper teeth by passing through minute canals in the substance of the bone, but in many cases, and more particularly the middle superior dental branch, which supplies the upper bicuspids and first molar teeth, pass downward and laterally directly beneath the mucous membrane. (See Figs. 60, 68.) The floor of the antrum is situated a short distance below the level of the floor of the nose and, as stated, the apices of the roots of the teeth situated directly beneath it may actually perforate the bony floor, or elevations of bone may be present which indicate the presence of the roots.

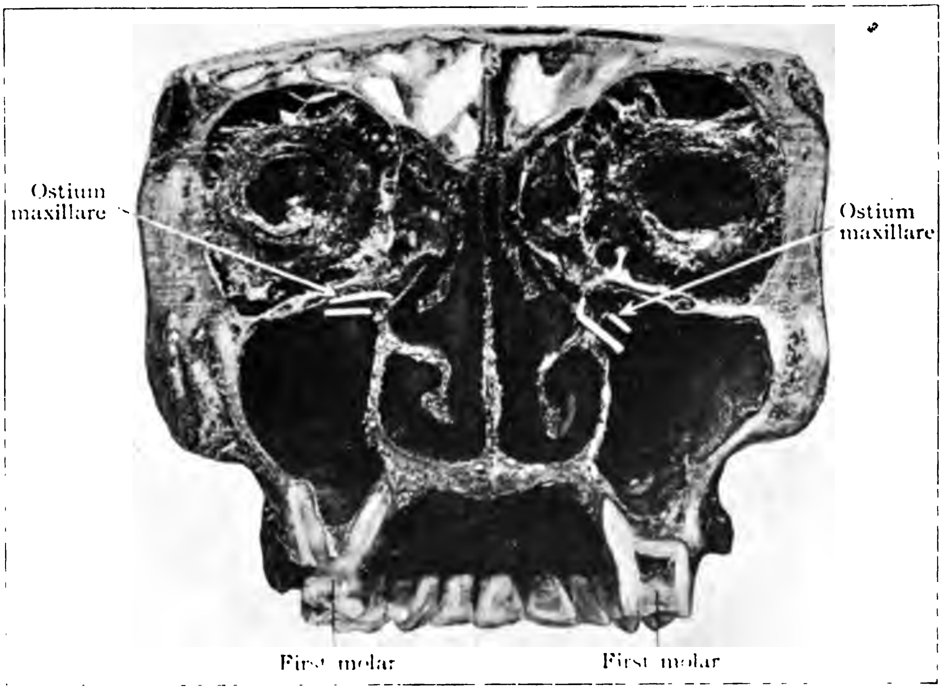


Fig. 479. Posterior view of vertical transverse section from the head showing the ostium maxillare, which is indicated on each side by a cord passed through it. (Retouched from Cryer.)

The maxillary sinus is lined by a thin delicate mucoperiosteal membrane, and the mucous layer of this membrane contains many mucous glands which may become infected, with the development of polypi or cysts. In some cases in which the anterior, middle or posterior superior dental nerves, forming the outer nerve loop, are situated in the mucous membrane and become irritated and inflamed, due to inflammation of the mucous membrane caused by infection, and the patient may suffer from neuralgia.

In chronic cases it is often necessary to do considerable curetting on account of necrosis during an operation for empyema of the antrum. In cases of this kind the patient may experience some numbness or anesthesia in some of the teeth supplied by the nerves injured, due to the pathologic condition or to the curettage.

Symptoms of Maxillary Sinus Disease. -The symptoms are pain, tenderness, edematous swelling of the face, and in many cases the thin bone may crepitate under pressure. The presence of pus is one of the most important factors, and a simple test, which can be made as a rule, will prove whether or not pus is seeping from the antrum. This is accomplished by inserting an applicator into the nose and wiping the mucous membrane in the middle meatus, and then have the patient lean forward with his head between the knees, retaining that position for several minutes. It is well to have the patient turn the head sideways so the side with the affected antrum is upward; this will tend to allow the pus to seep through the ostium maxillare. Have the patient retain this position for several minutes, then assume an upright position, and again introduce the nasal applicator, the middle meatus being examined for pus.

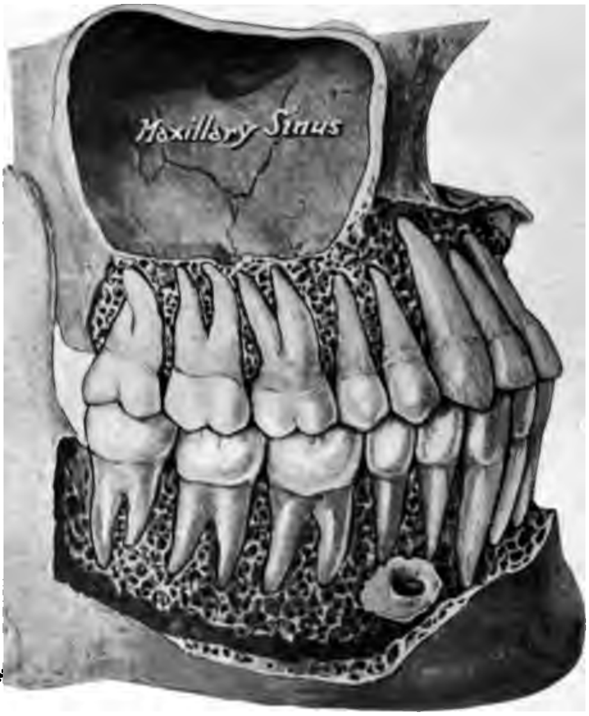


Fig. 489. Labial and buccal plates of bone together with the lateral wall of antrum removed, exposing the maxillary sinus and the roots of the teeth. (Retouched and modified from Spalteholz.)

Another test worthy of mention is to place the patient in a reclining position for some time, and if pus is discharged from the antrum, it will accumulate in the posterior portion of the sinus or escape into the nasopharynx, and may cause the patient to cough or clear his throat when he arises. In some cases the pus will discharge from the nose in an intermittent manner. In all infected cases the nasal speculum should be employed, and the operator should examine the mucous membrane just under the middle turbinate bone, which is the location of the ostium maxillare or opening into the antrum. In some cases of maxillary sinus involvement this opening leading from the sinus to the nasal cavity is partly or completely blocked. In acute cases the nasal aperture is usually blocked, thereby obstructing the discharge of pus which adds greatly to the intensity of the pain, the symptoms are more severe, and may merge into those of osteomyelitis. Neuralgia of the infraorbital nerve and its branches may accompany the pain and tenderness over the region of the antrum.

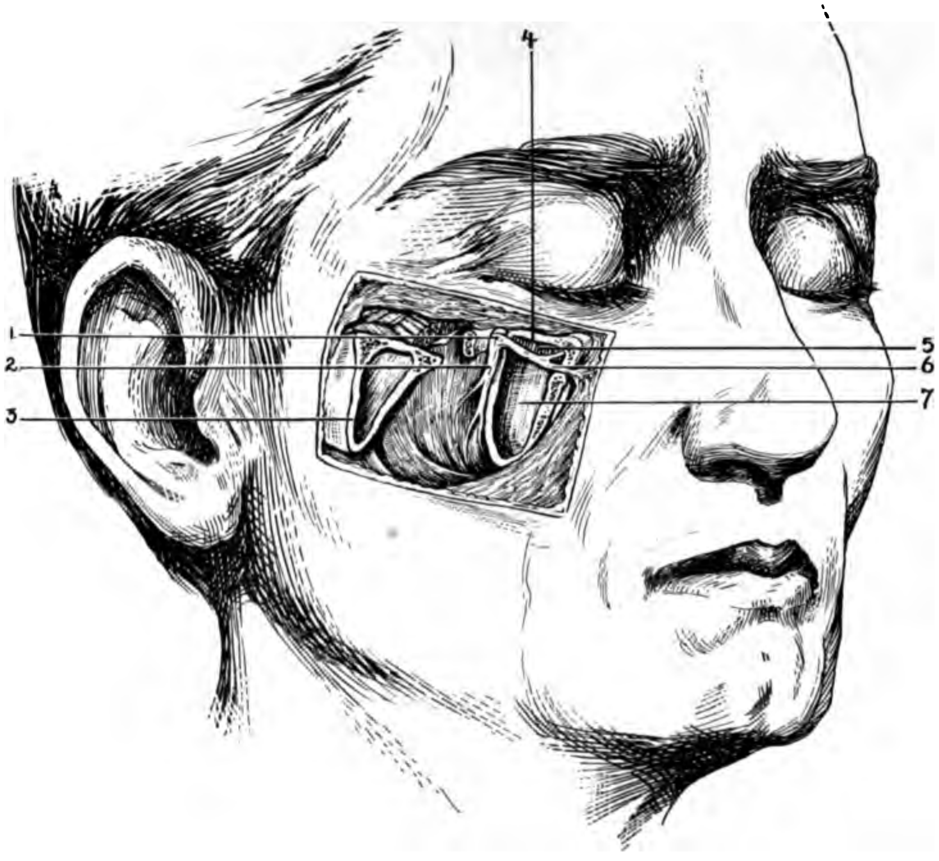


Fig. 481. Pen drawing showing region of antrum.

1, Posterior portion infraorbital nerve; 2, posterior superior dental nerve; 3, zygomatic bone incised; 4, floor of orbit; 5, infraorbital artery; 6, infraorbital nerve; 7, medial wall of antrum.

The opening of the antrum of Highmore, which connects with the nasal cavity, is located at the summit of the sinus (see Fig. 479), and it is for this reason that the patient's head is held downward between the knees in order that it can drain. If the infection is severe, the eyes will protrude and great tenderness in the alveolus and teeth will be experienced; in fact, the teeth will seem irregular to the patient, and he will experience pain when bringing them into occlusion. In most cases the cheek is swollen and very tender, the palate has the sensation of fullness, and the nasal duct may be blocked. In many cases the patient will complain of chronic headache.

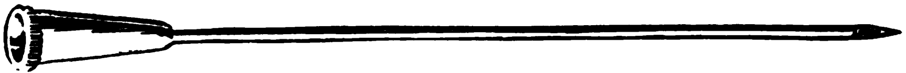


Fig. 482.—Lichtwitz's antrum needle.

Fig. 483.—Fein's antrum needle

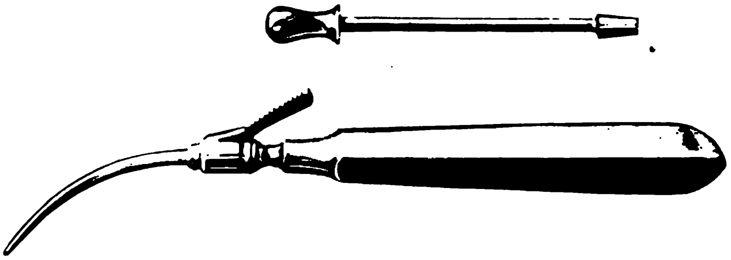


Fig. 484.—Mikulicz's antrum trocar and connection for rubber bulb.

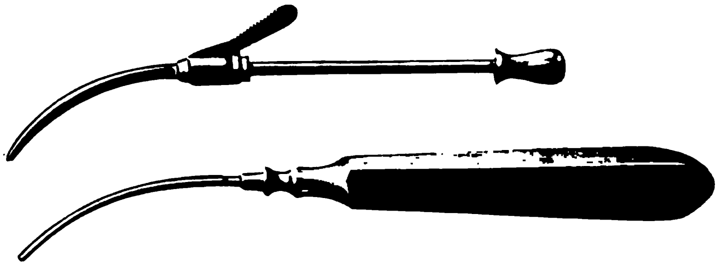


Fig. 485.—Mikulicz's trocar with stylet removed. Attachment for bulb connected to cannula.

Diagnosis.—The most important factors to consider in arriving at a diagnosis are:

1. The presence and recurrence of pus in the middle meatus.
2. Pain, swelling, and tenderness over the affected area.
3. Fullness in roof of mouth.
4. Pain in the alveolar process and irregularity of teeth.
5. In many cases it is possible to detect a difference in the two sides of the face.
6. Patient complains of headache and a disagreeable taste in the mouth on arising in the morning.
7. Transillumination by an electric lamp placed in the mouth and the lips closed over it. This test should be made in a dark room. There will be a diminution of light transmission on the diseased side as contrasted with the sound side. In other words, the diseased side will appear dark, instead of the normal rosy color under the eye. The light reflex on the diseased side is absent, that is, the pupil on the normal side will be visible, due to the transmission of light, while on the diseased side the pupil is invisible, due to the nontransmission of light. This is not always positive, as there may be an infiltration process of the lining over the floor without engorgement.
8. X-ray. Several x-ray plates if properly exposed, are valuable in diagnosis. The plates in most cases will reveal the pathologic condition due to the diseased tissues obstructing the x-rays, thereby showing a darkened area,

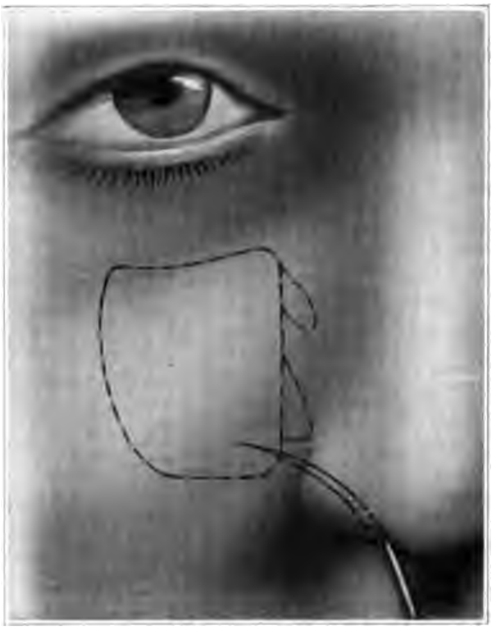


Fig. 486. Introducing curved hollow needle into the maxillary sinus, through anterior inferior portion of inferior meatus.

which is in contrast to the healthy side. However, the x-ray findings should not be taken as conclusive evidence that antrum involvement is not present. The x-ray findings should always be considered with the clinical findings.

9. Transirrigation. A trocar or a sharp hollow needle is inserted through the thin nasal wall located at the anterior inferior portion of the inferior meatus into the antrum. If pus is present, it may be that it can be aspirated, or fluid can be injected through the hollow needle or cannula of the trocar (see Figs. 482, 483, 484, 485, and 486). The patient's head can be held forward, and if the fluid is turbid as it passes from the nose, it indicates suppuration. This method is useful in arriving at a diagnosis.

10. Iridocyclitis; impairment of vision in the eye of the affected side; conjunctivitis; feeling of fullness of the eye as though there is not enough room in the orbit.

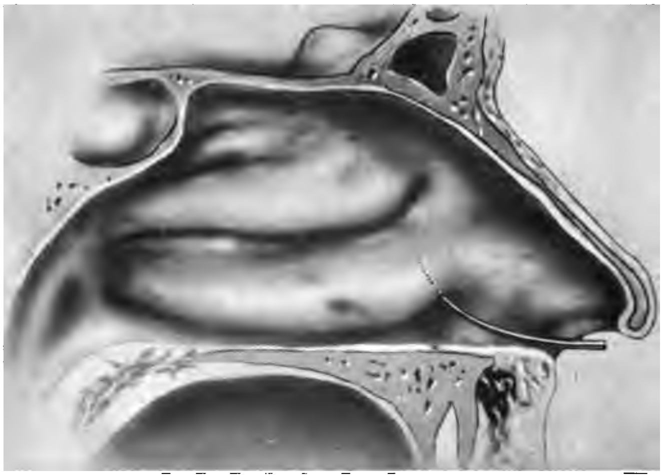


Fig. 487.—Entering the maxillary sinus with trocar through the nasoantral wall.

ETIOLOGY AND PATHOLOGY OF MAXILLARY SINUS DISEASE

The Source of Antrum Involvement.—1. From the extension of infection through the nasal cavity. Pathogenic microorganisms from the nasal cavity may enter the antrum through the osteum maxillare, and cause infection. 2. The infection many times is of dental origin, as from dead pulps, periostitis, extensive destruction caused by pyorrhea alveolaris; from an alveolar abscess; from impacted upper third molars; from abnormal pressure destroying the bones and tissues, resulting in inflammatory processes.

In many cases the apices of the roots of the second bicuspid, first molar, and in some instances the second molar, may penetrate the floor of the antrum, and in other cases the ends of the roots are so near the floor of the antrum that only a thin lamina of bone separates them, and if a dead pulp or an alveoiar abscess is present, infection may extend to the mucous membrane lining the antrum and cause infection.

3. The infection may be carried to the antrum through the blood or lymphatics. This is not a common occurrence, but it is always possible for infection to be caused in this manner.

The exciting cause is pathogenic bacteria, and the intranasal predisposing causes are various intranasal infections which produce pathological changes in the mucous membrane, such as acute or chronic rhinitis, hypertrophic rhinitis, influenza, frontal and ethmoidal sinus disease, obstruction of the ostium maxillare, infected and impacted teeth, tumors, cysts, etc. Infections such as these predispose the mucous membrane to attack, by lowering its normal vitality and resistance to inflammation and infection.

The author has found, after examining and treating a number of patients for maxillary sinus disease, that only a few of them possess sound teeth. This fact has led him to believe a high percentage of the cases of antrum involvements have their etiology from dental origin, in spite of the fact that a large number of eye, ear, nose and throat specialists claim that almost all cases of antrum infection have their origin from the nasal cavity. If the infection is from the nasal cavity, why is it we seldom see a patient with antrum disease and sound teeth? It is quite true infection may be of nasal origin, but the source of infection from this route has probably been overestimated. Some competent writers are of the opinion that more teeth are infected from antrum involvement than there are antra infected from diseased teeth. The author does not agree with them. Dr. Cryer has stated that 29 per cent of the antrum cases which have come under his observation have had their etiology from a dental source. Dr. Cryer deserves the credit for first calling attention to the fact that the frontal sinus and antrum frequently communicate with each other. This being the case, diseases of the antrum may not only be of a dental origin through infected teeth and surrounding tissue, from the extension of infection from the nose through the osteum maxillare, but may also be caused by infection in the frontal sinus. Dr. Brophy states that 75 per cent of antrum trouble is caused by diseased teeth. Dr. Oakman states that fully 90 per cent of all cases of antrum involvement are of dental origin. Both Ballenger and Luc state that the cause is equally divided between nasal and dental origin.

The operator should always remember that the source of infection may have its origin in the frontal or ethmoidal sinuses, and in making a diagnosis of the cause of infection these various sources should always be considered, and not eliminated until the real cause is discovered.

If the condition does not yield to treatment, and suppuration continues, the operator should search diligently for involvement of the frontal and ethmoidal sinuses. Infection may be present in these cavities, and the infected material formed in them may drain into the antrum. Parsons states that after examining a large number of cases he found that the frontal sinus communicated with the antrum in 56 per cent of the cases. The value of the x-ray should not be overlooked as it is a valuable adjunct in locating the focus of infection. When the roots of the teeth become infected, from the death of the pulp, or from a chronic pericementitis, alveolar abscess, or from extensive pyorrhea alveolaris, there may be some involvement due to the extent of the infection around the roots of the teeth which are located so near or in contact with the delicate mucous membrane lining the floor of the antrum, that infiltration of microorganisms through these tissues occurs and the cause of infection in these cases may be very easily accounted for in this way. It is likewise true that an enlarged middle turbinate or the inferior turbinate bone, is often covered with hypertrophied tissue in most cases where infection exists. In addition to the inflammation and hypertrophied tissue, an enlarged and hypertrophic turbinate may be present in some individuals, and the nasal septum may be so deflected as to cause inflammation, thus blocking the ostium maxillare. This blocking may occur every time the patient takes cold, and is caused by inflammation of the mucous membrane which may eventually become chronic. In case infection of the antrum arises from chronic catarrhal inflammation of the mucous membrane lining the nasal cavity, which is continuous with the antrum, the infection will extend from the nasal cavity, selecting as its route the hiatus semilunaris and the ostium maxillare, causing infection of the delicate mucous membrane lining the antrum.

The opening of the maxillary sinus is located in the upper part of the naso-antral wall, in the middle meatus below the bulla ethmoidalis, being hidden by the lower part of the processus uncinatis. (See Fig. 479.) It can be readily seen that this opening, which connects the nasal cavity with the maxillary sinus, is located a considerable distance above the floor. This makes it difficult or impossible for the drainage of exudate which may form in the antrum, except when the sinus is entirely filled and will overflow, or when the patient drops his head in such a position as will allow the contents to escape. The writer does not wish to leave the impression that during health this opening is continually discharging an exudate, as this is not true, because the mucous membrane lining the antrum only secretes a sufficient quantity of serum during health to keep the mucous membrane in a moist condition. The mucous membrane lining the sinus has a covering of modified ciliated columnar epithelium and, in case of excessive secretion the wave-like motion of these specialized cells aids materially in carrying the slightly increased amount of secretion or other material to the ostium maxillare, and discharging it into the middle meatus. As previously stated, in case of continued or even intermittent catarrhal inflammation of the mucous membrane, it becomes hyperemic, edematous and engorged, and infection may extend through the ostium maxillare and infect the mucous membrane lining the antrum. Should infection of the mucous membrane lining the antrum take place, the delicate cilia are impaired or entirely destroyed, if the secretions due to infection remain in the sinus. The secretions not only remain in the sinus, but their production is greatly augmented, by pathologic conditions existing in the mucous membrane. It must be remembered that the maxillary sinus is an air cavity during health, and it is impossible to have a healthy air cavity, such as this sinus, unless it communicates with the outer world. The reason for this is that all parts of the body absorb air; being deprived of air the mucous membrane lining the antrum becomes a frequent seat of pathologic involvement. If the lining mucous membrane could receive better ventilation and drainage, it would be more difficult to infect, but on account of its location and frequent lack of thorough ventilation and drainage, it is often the seat of infection. Knowing this to be a fact, the first principle in treatment is to establish thorough drainage and ventilation. Not only is it necessary to do this, but it is necessary to remove the pathologic material and arrest the source of infection. The exudative inflammation which follows infection may be serous, fibrinous, seropurulent, or purulent in type. This will depend, however, on the virulency of the inflammatory involvement. The pathologic stages which take place are as follows: The mucous membrane is invaded with leukocytes accompanied by an infiltration of serum. The surface of the mucous membrane is dryer than normal. Immediately following this process there is an engorgement of blood or, in other words, hyperemia of the tissue which causes a dilatation of the capillaries, giving the mucous membrane a red appearance, accompanied by increased temperature. Within forty-eight hours following this process, the leukocytes and serum which have been formed pass through the tissues to the surface of the mucous membrane, thereby mixing with cast off epithelial cells, microorganisms, and mucus. If the pathologic condition is extreme, a small hemorrhage may occur, due to the rupturing of the capillaries, and giving the exudate a darkened appearance. Later, the production of fibrin takes place which changes the first secretion of a serous nature to a thicker consistency on account of the fibrin coagulating with the serum. If the infection is of a mild type, resolution may take place by absorption of the secretion; if, on the other hand, the infection is of a more virulent type, the inflammation develops into seropurulent or purulent type, and even at this stage resolution may take place, but in all probability, tissue destruction intervenes and the case becomes chronic.

In some cases of antrum involvement, little or no pain is experienced by the patient, because the exudate is draining through the ostium maxillare, and when the patient lies down at night the discharge escapes. On the other hand, if the opening becomes closed and the secretion remains under pressure; pain, swelling and tenderness are soon experienced by the patient. The points of least resistance in the antrum are the membranous portion located in the region of the middle meatus, and in some cases the superior and anterior bony walls are exceedingly thin, and may bulge or become perforated due to the intense pressure of the retained exudate. It will be noted that one of the important symptoms in diagnosing empyema of the antrum is that of extreme tenderness over the anterior wall; also, if the roof or orbital portion of the antrum becomes distended due to the pressure, it may give rise to abnormal movements of the eyeballs on account of the involvement of muscle and connective tissue situated beneath the eyeball. If the infection continues and is of a virulent type, the mucous membrane lining the antrum, on examination may present a roughened or granular surface, excessive granulation, extreme thickening, or polypoid growths. Exuberant granulations and polypi which may form in a chronic case are easily observed during the operation by direct examination with the diagnostic illuminating lamp.

A chronic suppurative condition may cause a certain amount of necrosis of the walls of the antrum, and during operation a most careful examination should be made, and all such tissue carefully removed. The mucoperiosteal lining should be protected, and, when possible, should not be destroyed or the bony wall uncovered.

Quoting from Dr. Oakman's paper published in the National Dental Journal, March, 1920, as follows: "The chronic forms of sinus empyema are frequently associated with pharyngeal disturbances, resulting in a granular or hyperplastic condition.

"Grünwald states that all nasal polypi are practically pathognomonic of accessory sinus disease, ethmoids especially.

"Uffenorde asserts that they have absolutely no relation to it. Kaufmann states that in many cases empyema of the maxillary sinus was the only cause for the polyp formation.

"Heymann is of a different opinion and states that the secretion causes an irritation to the smooth mucosa which results in the formation of inflammatory papules, which is followed by hyperplasia, and the resultant edema causes the formation of small polypi.

"Yowge states that the glands undergo cystic degeneration by obstruction of their ducts, thereby forming polypi.

"Skillern states that one symptom indirectly caused by the secretion when present, which is almost pathognomonic of sinus disease, is this subjective appreciation of an offensive odor in the nose. This is usually intensified by sudden sharp inspiration through the nostrils. The cause of the condition is due to the putrefaction of the secretion of saprophytic microorganisms."

"Dentigerous cysts. These are caused by disturbance in dentition. Those due to unerupted teeth and those due to inflammatory changes in the peridental membrane of the tooth frequently follow the death of the tooth pulp.

Palliative Treatment.—It is necessary in most cases to render assistance to a patient before an operation is decided upon; therefore, it becomes necessary to treat patients medicinally. If the ostium maxillare has been closed, due to an enlarged turbinate, or hypertrophied or inflamed tissue, many times the unplugging of this opening will render relief. However, with the closure of this opening, the inflammatory exudate will cause pressure on the sensory nerves, and the patient will in many cases suffer severe headache and intense pain. The writer has secured excellent results by using a 20 per cent solution of procain in 1/1000 solution of adrenalin hydrochlorid applied to the mucous membrane in the region of the ostium maxillare with an applicator. The adrenalin hydrochlorid causes a constriction of the tissue at this point, and in many instances the opening will be reestablished.

Irrigating the nose with warm Ringer solution or steam; with vapor from tincture benzoin compound (i5 in one quart of boiling water), inhaling the steam, will aid in relieving congestion. Steaming with hot moist cloths on the face will aid materially in reducing pain and often assists in establishing nasal drainage.

Another method which has been found very efficient is to allow the patient to sit down, bending forward as much as possible with the head between the knees or have him lie across a table or bed with his face downward and his head hanging over the edge. The nostril of the unaffected side should be closed with the finger, and the patient should blow: this causes a suction past the opening of the ostium maxillare, which in some cases will start draining, especially when the patient's head is assuming the position described. There should always be a thorough elimination of the alimentary canal by administering two grains of calomel, followed by a saline cathartic.

Upon examination, if the patient is suffering from acute rhinitis, the mucous membrane lining the nasal cavity will be found highly inflamed. The symptoms are characterized by an increased temperature, a feeling of fullness and discomfort in the head, with an abundant discharge of fluid, watery, mucous, or mucopurulent in character. The repeated blowing of the nose and constant irritation, which is caused by the discharge, will spread the infection. The inflammation extending to the ethmoidal or sphenoidal cavity, or to the frontal sinus, may cause increased and severe frontal headache which may extend to the ostium maxillare affecting the antrum, and at the onset will cause extreme tenderness of the teeth which may be unilateral or bilateral. Upon examination, if this condition is found, and the symptoms indicate that the antrum is involved, the following treatment is employed: Administer 5 grains of aspirin, repeated every thirty minutes until 15 grains are taken, or the early administration of 10 grains of quinin sulphate with morphin sulphate, in 1/6 grain doses, or Dover's powder in 5 grain doses, will often serve to abort an attack. In addition to this, a hot mustard foot bath together with rest and purgation by saline laxatives will aid wonderfully in the abortive treatment.

The following prescription has proved very successful at the onset, if the patient is suffering from a nasal complication:

℞ Aluminis sulphatis
Bismuth subcarb.
Pulv. camphorae ....āā gr. xx
Morphinæ sulphatis ....gr. ii
M. Ft. chart No. xx.
Sig.:—Insufflate one powder in each nostril after clearing the nose.

If the attack has already developed, relief can be obtained in nearly all cases by administering two minims of tincture of belladonna every hour until six doses are given, after which follow with one drop every three hours until the physiological effect of the drug is manifested. Full doses of camphor are also of value. Spraying the nares with a 20 per cent solution of procain with 1/5,000 solution of adrenalin hydrochlorid, or a 5 per cent solution of cocain hydrochlorid, and the same percentage of adrenalin hydrochlorid, as above, given with caution, will in many cases give relief. The nasal cavity should, at all times be kept clean with an efficient alkaline solution, such as Dobell's.

ROUTES OF ENTERING THE MAXILLARY SINUS FOR SURGICAL TREATMENT

1. The intranasal route.
2. The extranasal route.
    1. Through antero-lateral wall of antrum.
    2. Through alveolar process.

The selection of the method of surgical procedure depends upon three factors:

1. The case in an acute state.
2. The case which is chronic.
3. The extent and involvement of the tissues.

Not only does the selection of the surgical procedure depend upon the three factors named above, but we may also add that the ability of the operator has a great deal to do with the selection of the operation. He should not attempt one of the operations which demands considerable incising of the tissues unless he thoroughly understands the anatomy of the tissues involved, and the surgical and blocking technic. If the case is chronic and has been discharging pus for a considerable time, there will probably be considerable involvement of the bone and soft structures, which would need to be removed, and the mere insertion of a trocar by the intranasal route and treatment instituted in this manner would prove of little or no value. One of the more radical operations should be performed for permanent relief. If the operator is not thoroughly familiar with the technic of performing one of the operations, referred to later, the case should be referred to an oral surgeon for treatment.

LOCATION FOR OPERATION

1. Perforating the antrum through the nasal cavity.
2. Entering the antrum through the cuspid fossa.
3. Operating through the alveolar process.

One of these three locations is selected for entering the maxillary sinus, and the chronicity of the process has a great deal to do with the selection of the operation. It is always good practice to employ the simplest and most effective method.

There has been considerable discussion among specialists as to whether the maxillary sinus should be opened through the alveolus by the intraoral route, or whether the more modern methods should be employed. All three routes of entering the sinus have their objections. It should be definitely determined, if possible, whether the infection is of dental origin and, if this is found to be the cause, it must be remedied. This is the first stage in the program of relief. If later it is found that other surgical procedure is indicated, it may be done to meet the needs of the particular case in hand.

The principal objections to the intraoral route of opening through the alveolar process are:

1. In some instances it is necessary to sacrifice a sound tooth.

2. The possibility of contamination from the secretions of the oral cavity, carious teeth, infected tonsils, and food taken into the mouth.

3. The discharge of pus from the antrum into the mouth adds a great deal to the discomfort of the patient.

4. The toxicity which may arise as a result of the patient swallowing pus may have a general toxic action.

5. In many instances, if a large opening is made through the alveolar process, it tends to remain patent for a considerable time, due to the slow regenerative powers of the tissues in that region, which will add to the possibility of reinfection.

6. By the alveolar operation, if only a small opening is made, some difficulty may be experienced in keeping the artificial opening patent on account of the coagulated blood, pus, etc., and not allow drainage. However, this may be an advantage.

The objections to the nasal route are:

1. The operator may experience difficulty in reaching the antrum by the nasal route.

2. Reinfection from the nasal cavity may take place. The nasal secretions, and dust which is inhaled may cause reinfection, and if a permanent opening is made it may be a continual source of annoyance and care to the patient.

3. It is impossible in some cases to reach the lower point of the antrum so the pus will drain without the possibility of subsequent inflammation or severe hemorrhage.

The objections to the cuspid fossa route are:

1. The incising of the tissues covering the cuspid fossa, and the removal of the anterior wall of the antrum is more radical than when the operation is performed through the alveolar process. This in many cases must be supplemented by at least a small opening through the nasoantral wall for drainage

2. Obtaining free access to the cavity of the antrum for thorough aftertreatment cannot be accomplished as easily as is the case by the intraoral or intranasal route. Entering the cavity for thorough postoperative treatments where there has been considerable involvement of bone and other tissues is advantageous and if this route is selected it may be necessary to leave an opening and pack the same with iodoform or iodized gauze. In some cases, however, the incision is closed with sutures at the time of operation.

METHODS OF ENTERING THE MAXILLARY SINUS BY THE INTRANASAL ROUTE

1. Puncturing the nasal wall through the anterior portion of the inferior meatus with a trocar.
2. Resection of a portion of the nasal wall through the inferior meatus.
3. Canfield's method.

TECHNIC OF PRODUCING LOCAL ANESTHESIA FOR INTRANASAL METHOD OF ENTERING MAXILLARY SINUS

Before operating on the antrum of Highmore, whether with a trocar or removing a part of the nasoantral wall, care must be taken to anesthetize the tissues of the operative region. Some operators advise applying cocain crystals direct to the mucosa in the operative region with an applicator moistened with 1/1000 solution of adrenalin. Others advise the employment of a 10 per cent cocain solution with adrenalin, the same being applied by direct application to the mucosa. The use of cocain is not advised because we have at our disposal today several local anesthetic agents that are less toxic, with which excellent anesthesia can be obtained. Procain crystals, instead of cocain, may be employed, using the same technic as described, or the following mixture is employed and advised by the writer:

℞	Phenolis	Grams 1
	Procainae pulves	Grams 5
	Aqua dest.	Mils 30

Misc. Add one minim, 1/1000 sol. adrenalin per mil. at time of applying.

Sig.: Apply to mucosa with gauze pack, leaving it in position for ten minutes.

After the gauze pack has been left in position for ten minutes, it is removed, and 2 c.c. of a two per cent procain suprarenin Ringer solution is injected beneath the mucous membrane and periosteum covering the inferior meatus. Only one insertion of the needle is necessary in most cases. The needle employed depends upon how far it is to be inserted posteriorly beneath the mucous membrane covering the nasoantral wall. A needle from 30 to 50 mm. in length, 24 gauge iridioplatinum, is employed. The nasal speculum is used while making this injection.

The amount or area of anesthesia depends upon the nature and extent of the operation. If the operation is for puncturing the antrum through the nasoantral wall and located at the anterior inferior portion of the inferior meatus, the trocar or hollow needle is employed. (See Figs. 483 and 484.)

It is then only necessary to anesthetize the mucous membrane and thin bone separating the antrum from the nasal cavity to a point midway between the anterior and posterior boundary of the inferior meatus. The mucous membrane and bone, composing the anterior half of the inferior meatus, are anesthetized. In case the more radical operations are employed for entering the antrum, such as the simple resection, that is, the removal of a part of the wall of the inferior meatus, or the entering of the sinus through both the inferior and middle meatus, a much more extensive anesthesia must be produced than for entering the sinus with the trocar or hollow needle. It would then be essential to use the tampon freely, and it should be packed into the nasal cavity, allowing it to thoroughly cover the mucous membrane which is to be involved in the operation. The packing is placed far enough posteriorly to anesthetize the sensory nerves which enter the mucous membrane posterior to the nasal cavity. If the Canfield type of operation is selected, it is necessary to anesthetize a greater amount of tissue than in any other of the above named operations, because the Canfield method involves more tissue, not only in the nasal cavity, but on the anterior surface of the superior maxillary bone. In addition to the nasal tampon saturated with the anesthetic solution and left in place for at least ten minutes, the author advises the blocking of the second division of the fifth nerve by intraoral method. (See page 380 for technic.) If the proper amount of adrenalin is contained in the anesthetizing solution, anesthesia will be maintained throughout the operation unless the operator is very slow in completing his work. The author employs a solution containing 1/1600 or 1/3200 of a grain of suprarenin or adrenalin per mil, and ⅓ grain procain per mil with Ringer constituents. (See page 258.)

When the correct quantity is injected, as given under the blocking of the second division of the fifth nerve, profound anesthesia will be maintained forty-five minutes in the average case, which in most instances is more than ample time for antrum operations of this character. Unless the right and left second divisions of the fifth nerve are blocked, some sensation may be present in the tissues along the nasal wall, near the median line, and in case such is present, reapply the tampon containing the anesthetizing solution to the naso-antral wall which blocks any of the sensory anastomosing fibers on the opposite side.

The injection the operator must make to produce anesthesia depends upon the nature and extent of the operation, and if he has the nerve supply definitely fixed in mind, no trouble should be encountered in producing profound anesthesia for any of these operations upon the maxillary sinus.

TECHNIC OF BLOCKING FOR EXTRAORAL MAXILLARY SINUS OPERATIONS

It is not difficult to block the antrum and surrounding tissues so the sinus may be opened, and the bone curetted and treated, if necessary. The anterior lateral walls of the antrum may be anesthetized in the following ways:

1. By blocking the second division of the fifth nerve, by either the extraoral or intraoral method. (Blocking at this point will anesthetize practically the entire jaw. See technic for additional injections under Resection of the Superior Maxilla in Chapter XXX.

2. By injecting the solution at the infraorbital foramen, thereby blocking the anterior superior dental and terminal branches of the infraorbital nerve. (See technic, page 459.)

3. By terminal circular method of anesthesia.

The method of local anesthesia to be employed depends upon the nature and extent of the pathologic condition of the antrum. The mere blocking of the anterior and lateral surface of the antrum by either the infraorbital nerve blocking injection or by the terminal method, is in some cases not sufficient to produce complete anesthesia of the sensitive mucous membrane lining the antrum, which may be in a state of acute inflammation. If the pathologic process is localized, more or less, or has not involved the mucous membrane lining the antrum, and a large quantity of solution is injected, it will in most cases penetrate the anterior and lateral walls of the antrum to anesthetize the interior mucous membrane. For such cases the blocking of the second division of the fifth nerve by the intraoral method is recommended. This injection is far more satisfactory for such cases, inasmuch as it blocks the entire second division of the fifth nerve and does not depend upon the solution being diffused through the bony plate. The upper jaw is innervated by the second or maxillary division of the fifth nerve, and the blocking of this nerve is easily accomplished when the technic is understood; also anesthesia will be secured over a large area which permits operating without pain to the patient.

INTRANASAL ROUTE OF ENTERING THE MAXILLARY SINUS

Technic of Entering Maxillary Sinus by Puncturing the Nasal Wall.—This is a simple and efficient method of treating a pathologic condition of the sinus and is valuable in arriving at a diagnosis. It is of value in treating acute or subacute cases of inflammation and is often sufficient to effect a cure without resorting to the more radical surgical procedure. Clinical experience teaches that a small opening through the mucous membrane and thin bone readily closes, whereas many times an opening of larger size does not close readily. The point of puncture is located in the anterior part of the inferior meatus, beneath the inferior turbinate bone. This area is readily reached. The bone separating the antrum and nasal cavity at this point is very thin. The anterior part of the inferior meatus is selected. By inserting the trocar through the inferior meatus it makes the distance much farther to the orbit; besides it is at a lower level, which will aid in discovering the presence of pus by aspiration. The pressure exerted should be outward toward the cheek.

There are several kinds of instruments employed for this purpose; the three which are the most popular are the Mikulicz curved trocar, Fein's and Lichtwitz's antrum needles. (See Figs. 482, 483, and 484.) The author prefers the former for the reason that it has a cannula and an extension which can be attached to a rubber bulb, or a Politzer bag can be connected. The trocar is inserted in the proper location and firm rotating pressure is exerted upon the instrument until it penetrates the thin bony wall and drops into the antral cavity. The difficulties encountered many times when employing a needle are that often its lumen becomes filled with mucus, pus, bone, or the end may become engaged beneath the periosteum. The possibility of the needle becoming clogged is entirely eliminated if the trocar is employed. The trocar and cannula should be properly curved so the desired area can be reached, and even with a curve it is necessary to hold the instrument across the median line on the opposite side of operation. (See Figs. 486 and 487.) After the antrum has been entered the stylet is removed leaving the cannula in position. The cannula may be introduced daily, after applying the anesthetic pack for treatment, with little inconvenience to the patient. In some cases some operators advise irrigating the antrum. Various solutions are employed, such as Ringer solution, ½ per cent Carrel-Dakin solution, or a ½ per cent solution of tincture of iodin. If the discharge becomes fetid, employ 1 to 2 per cent solution of phenol, 1/3000 solution bichlorid of mercury, or ½ to 1 per cent solution of permanganate of potassium. It is often difficult for the operator to decide whether to irrigate or not. In most cases an operation is preferable, and the trocar is used merely as an aid in diagnosis. Dr. Brophy prefers entering the antrum through a small opening in the cuspid fossa in preference to opening through the nasoantral wall. After the opening has been made, he inserts the small point of a syringe making pressure through the opening. The infected material will be forced through the ostium maxillare if not obstructed by inflammation.

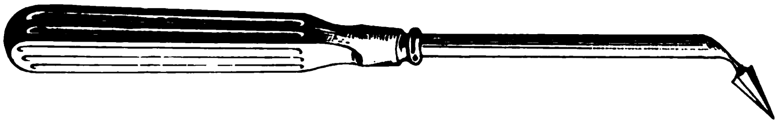


Fig. 488.—Welhelmenski's antrum trocar.

THE SURGICAL REMOVAL OF A PORTION OF THE NASOANTRAL WALL

The credit for operating through the nasoantral wall belongs to Myles, and since he introduced this to the profession a number of years ago it has had many advocates among the rhinologists, but has never been popular with oral surgeons. A number of instruments have been devised for this operation which enable the oral surgeon, or eye, ear, nose and throat specialist to do the operation with precision and ease. The technic for employing some of these instruments will be discussed later.

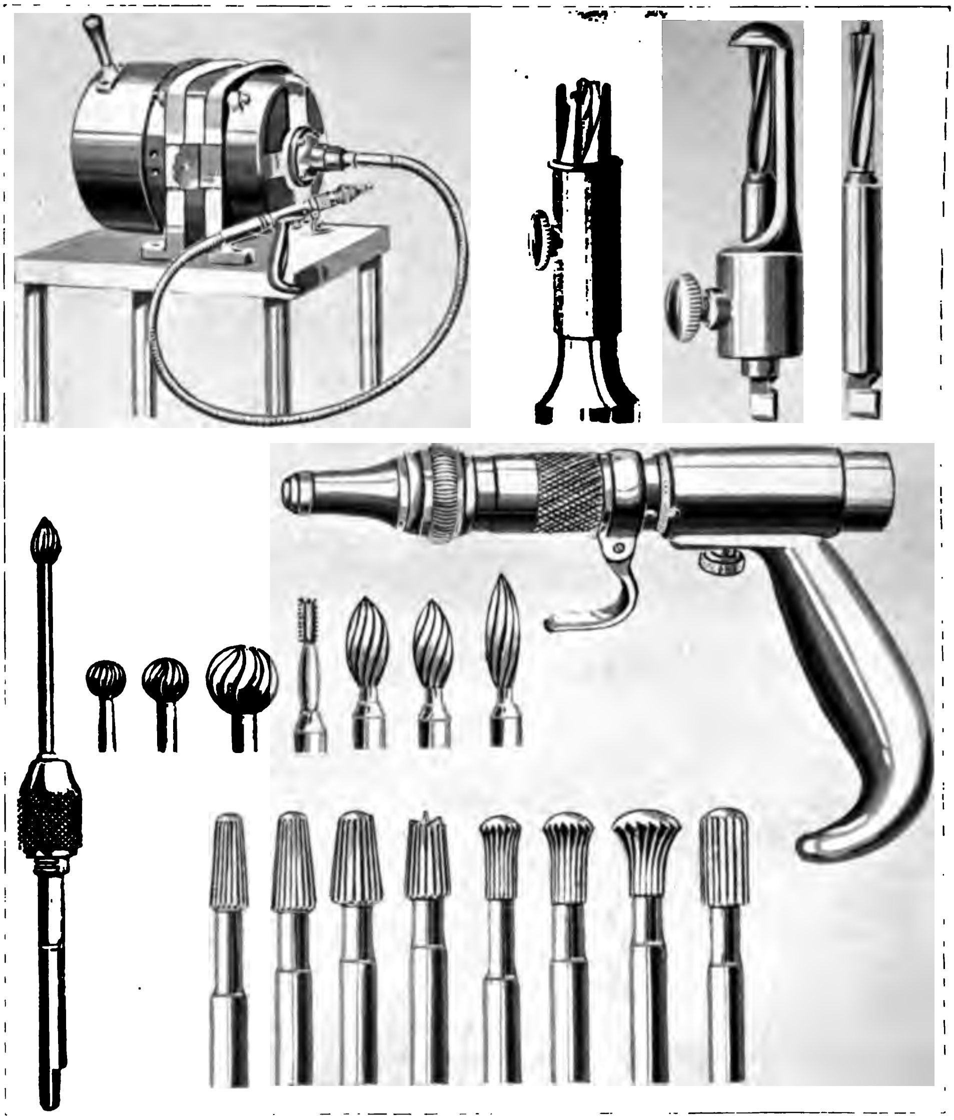


Fig. 489 Electric dental engine and Halle's handpiece with burs.

ENTERING THE ANTRUM THROUGH THE ANTRONASAL WALL BY SIMPLE RESECTION

Entering the antrum through the nasoantral wall for the treatment of disease is practiced to a considerable extent by some oral surgeons, and eye, ear, nose and throat specialists with excellent results. The author has previously stated that in many cases of infection of the antrum in the acute or subacute stage, results can be obtained by puncturing the antronasal wall with the trocar. If the pathologic condition does not yield to treatment by the simple puncture, then the operator must resort to the more radical procedure. In some cases the method of simple resection of the nasal wall through the inferior meatus is selected. This method has some advantages over the other routes; however, it has disadvantages, for in some cases the opening made is very slow in closing, and may be permanent unless a flap of mucous membrane and periosteum is made to cover the opening. The extent of the operation and the amount of tissue to be removed will depend upon the extent of the pathologic involvement and the condition of the inferior turbinate. If the inferior turbinate is large or extends down over the inferior meatus, or if the inferior meatus is exceptionally small, it is advisable, in addition to making an opening through the antronasal wall, to first remove a small portion of the inferior turbinate bone. In case a portion of the inferior turbinate is not removed, if it is unusually large, and the antrum is entered, in all probability it will not allow free drainage, thus requiring a second operation for the removal of the inferior turbinate. Hence a careful examination of this bony process should be made, and the operator must determine whether or not it should be removed prior to entering the antrum through the inferior meatus.

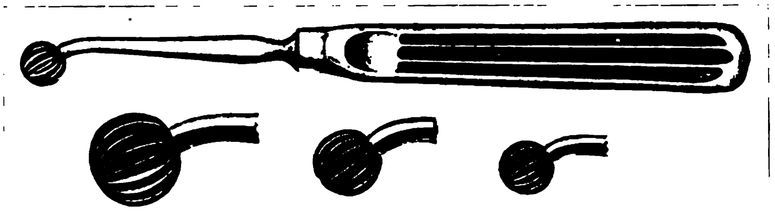


Fig. 490. Tilley's antrum burs.

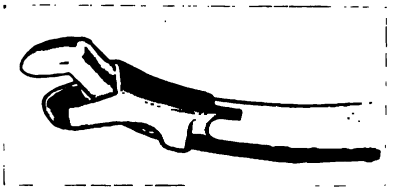


Fig. 491. Wagner's antrum punch.

The first step in entering the antrum is to spray the nasal cavity with an antiseptic solution, and then produce complete anesthesia of the part. The next step is to enter the antrum with a sharp instrument, such as that designed by Welhelmenski. (See Fig. 488.) Or, instead of using one of these sharp instruments, a large curetting bur, as illustrated in Fig. 489, is placed in the electric engine and is advanced through the anterior inferior portion of the nasoantral wall of the inferior meatus. If the Welhelmenski instrument is employed, the next step in the technic is to employ a large bur which is controlled and rotated by the hand. This large bur (see Fig. 490) is placed in the opening which has been made by the previous instrument, thereby enlarging the opening. This hand bur will be found very efficient, and the operator can take his time in enlarging the opening, and not cause any damage to the adjacent tissue. He should, however, at all times, have perfect control over the instrument. Instead of employing the hand bur for enlarging the opening, other instruments that will be found of exceptional value

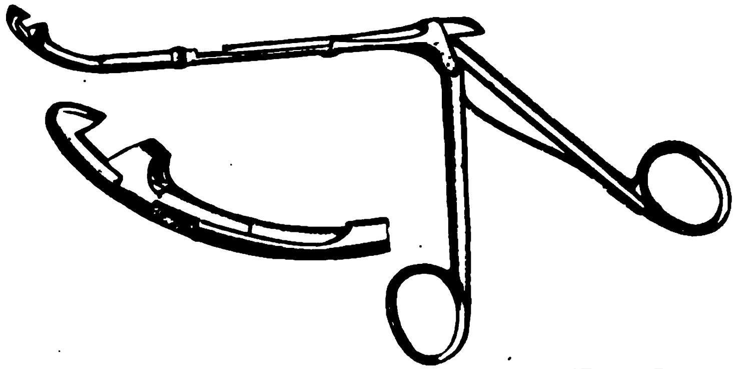


Fig. 492.—Spies' antrum punch.

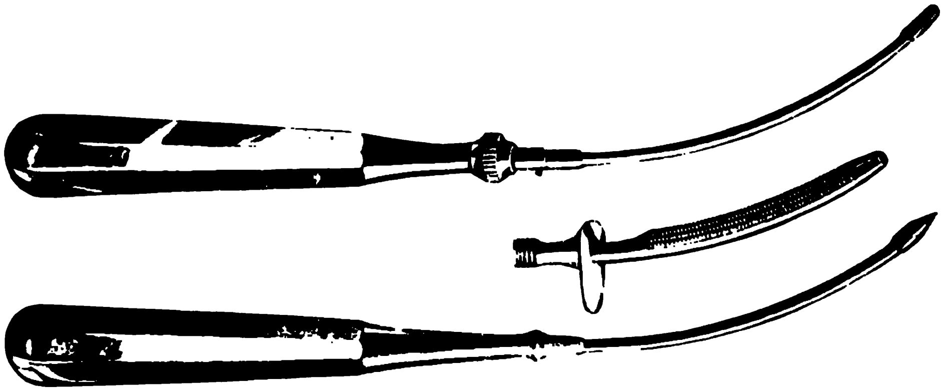


Fig. 493.—Wells' trocar cannula rasp for enlarging aperture in the nasoantral wall.

are the Wagner's antrum punch (see Fig. 491) and Spies antrum punch. (See Fig. 492.)

Another efficient instrument is the Wells trocar-cannula rasp. (See Fig. 493.) After this instrument has been extended through the nasoantral wall, the obturator is removed and the rasp is employed to remove the bone. This instrument is very efficient, and the operator should consider it a very essential adjunct to his armamentarium.

Good technic can be carried out by the use of hand instruments, but since the advent of the electric engine and the improved electric hand piece, it has somewhat revolutionized the technic for bone work.

With the electric engine (see Fig. 489), when equipped with the Halle hand piece and with the proper burs, excellent results can be obtained.

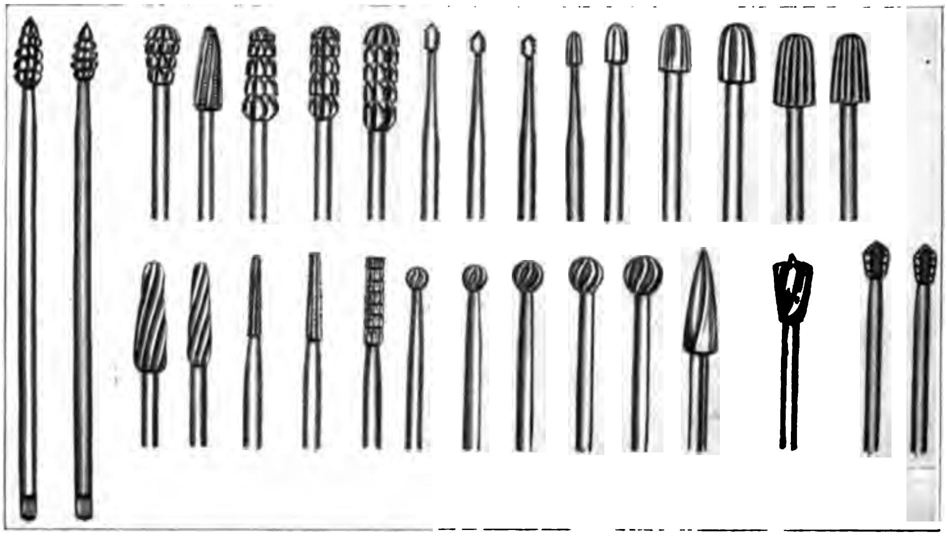


Fig. 494.--Surgical burs.

Much care should be used in the control of the bur not to engage and mutilate the tissues. The operator must be very careful in the use of the electric engine, as he can do considerable damage to the adjacent tissue, and great emphasis should be laid upon this fact. The advantage of using the Halle hand piece is that it is equipped with the trigger arrangement (see Fig. 489) and the bur does not rotate unless the trigger is pulled back pistol fashion. The operator should equip himself with a number of burs (see Fig. 494) of various sizes and shapes which will enable him to reach various places while operating.

Fig. 495 shows a median section illustrating the Wagner forceps in position. This instrument is used after the electric or hand bur. In case the inferior turbinate bone is large and extends downward over the inferior meatus the anterior portion can be easily fractured and turned inward and upward, thus exposing the inferior meatus, so this area can be readily reached by the instrument for entering the sinus, and after the sinus has been entered, the anterior portion of the inferior turbinate bone, together with its mucous membrane, can be restored to its normal position. The operator must exercise good judgment in deciding whether it is better to operate upon the inferior turbinate bone in this manner, or whether to attempt entering the maxillary sinus in the restricted area. Instead of employing the various punch forceps for enlarging the small original opening, Vail's saws can be utilized to excellent advantage for this purpose. (See Fig. 496.)

Vail's Operation.—Vail's operation is considered by many to be an ingenious and practical method for resecting the nasoantral wall. Vail's saw is not flat, but curved, and when introduced into the antrum through the nasoantral wall, in an oblique position, it will make a round or oval incision, and by so doing will remove a portion of the bone. It is necessary, not only to produce anesthesia of the mucous membrane and inferior meatus, but of the inferior turbinate and middle meatus because the incision made by the Vail saw extends through the inferior turbinate bone. (See Figs. 497 and 498.) The anterior portion of the inferior turbinate bone can be removed by biting forceps, scissors, or swivel knife. The Vail operation consists of first puncturing the nasoantral wall at a point anterior and inferior to the anterior portion of the inferior meatus with a sharp instrument, such as the Welhelmenski trocar or a bur. After this initial opening has been made, the next

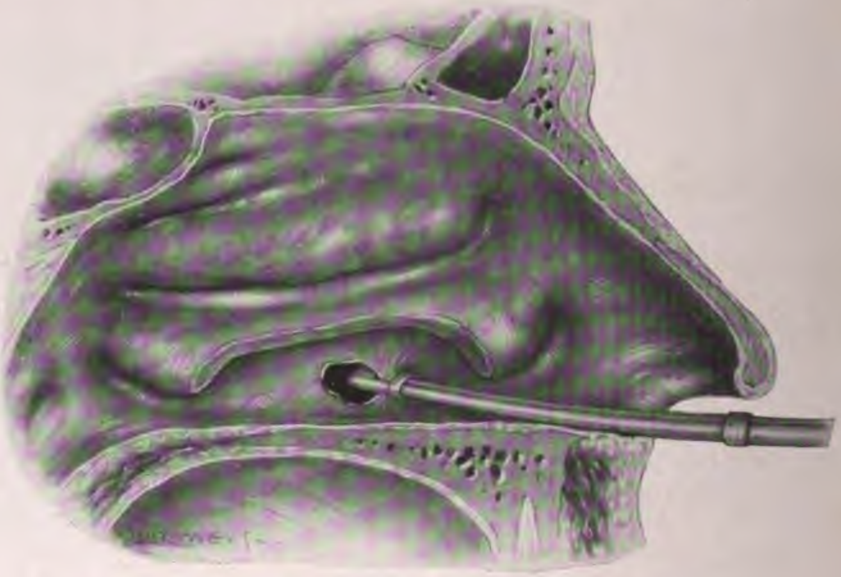


Fig. 495.—Opening the maxillary sinus with Wagner's punch forceps. (Loeb.)

step is to introduce the Vail saw. The saw should be held in an oblique position (see Fig. 497) and an oval or circular incision made. The diameter of the opening can be made in accordance with the operator's wishes, as the tissue is very thin at this point. However, care should be exercised not to make the opening too small, as in many instances its diameter, if not of sufficient size, will tend to close and free drainage will not be established.

The operator should carefully outline the field of operation before making his incision. After the anterior portion of the inferior turbinate bone has been removed, as illustrated in Fig. 498, it will be noted that the upper portion of the flap is bounded by the upper portion of the inferior turbinate bone, while the pedicle is located on the lower side. (See Fig. 497.) A periosteal elevator such as shown in Figs. 163 and 171 is inserted beneath the mucoperiosteal flap at its anterior edge, and gently extended backward and upward, separating the periosteum and mucous membrane from the thin nascantral wall. The flap is turned downward as is seen in Fig. 497. After the mucoperiosteal flap has been treated thus far, the Vail saw is inserted through the small opening which is seen in Fig. 497, and a circular piece of bone is removed, the operator being very careful not to cause laceration of the pedicle attached to the flap. The antrum is examined and curetted, and the flap is either turned outward over the floor of the antrum or is left in position to be used later to close the opening.

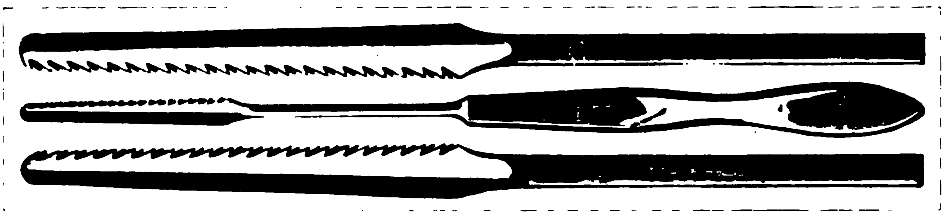


Fig. 496.—Vail's saws for entering maxillary sinus.

It may be advisable in some cases to pack the antrum with iodoform or iodized gauze, care being taken to see that the gauze is packed loosely. The gauze should be removed the day following the operation and replaced with fresh, which should be removed in forty-eight hours. The placing of iodoform gauze in the antrum should be continued for two or three days or longer if, in the judgment of the operator, it is necessary. The patient should be asked to return every other day, and a careful examination should be made of the mucous membrane to see whether or not granulation tissue is forming, and in case it is, it should be promptly treated by the application of an efficient caustic, such as silver nitrate, or dehydrated chromic acid crystals. Upon examination of the antrum with the illuminating lamp (see Fig. 499), if it is found that granulations are present; in addition to using an efficient caustic, the antrum may be irrigated with a ½ per cent Carrel-Dakin solution, or a Ringer solution if pus is present. The operator should remember that if the opening through the nasoantral wall is small, ample drainage may not be secured, and it may be advisable to insert a gauze drain or leave a small

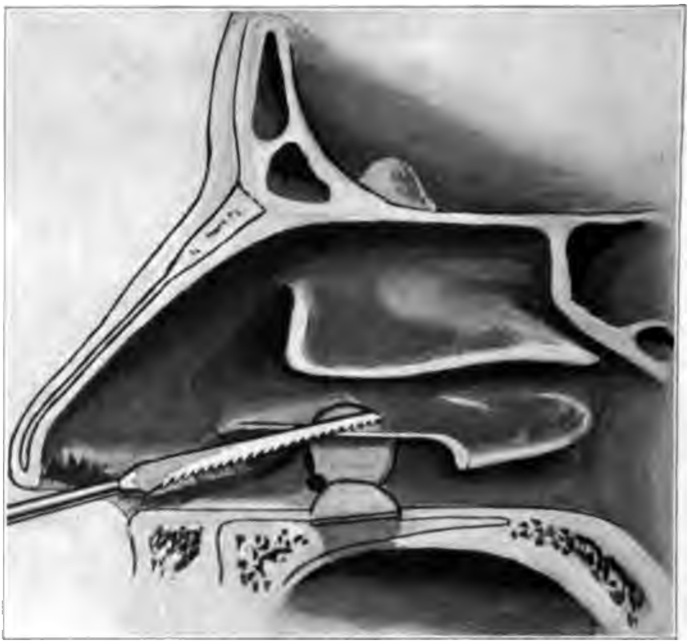


Fig. 497. Opening into the antrum with Vail's convex saw. A mucous membrane flap is resected from the nasoantral wall. (Retouched after Ballenger.)

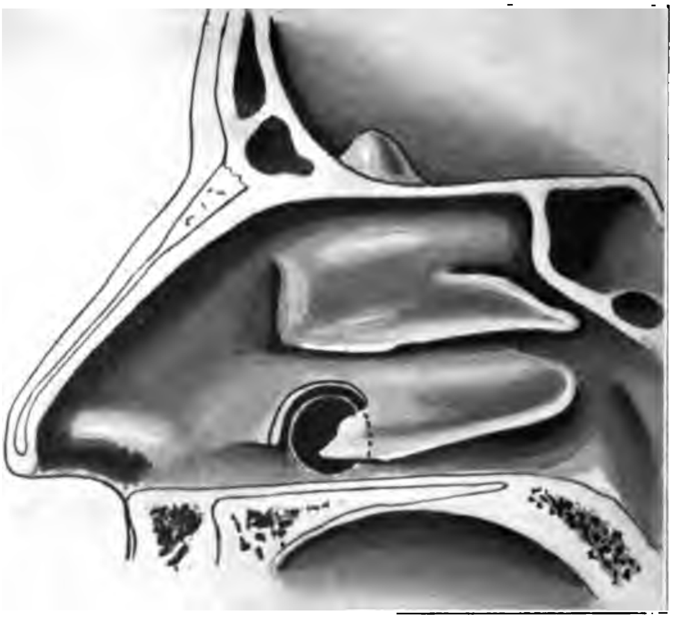


Fig. 498. Vail's operation on the antrum. The fragment of the turbinate extending over the nasal antrum should be removed with biting forceps or removed by use of Vail's saws. (Retouched after Ballenger.)

portion of the iodoform gauze extending through the opening into the nasal cavity.

SURGERY OF THE ANTRUM BY OPERATING THROUGH THE MIDDLE AND INFERIOR MEATUS

As a rule, the Vail method of operating not only includes the bone forming the anterior portion of the inferior meatus, but involves a small portion of the nasoantral wall of the middle meatus. The writer has classified the Vail operation with those of entering the maxillary sinus through the inferior meatus.

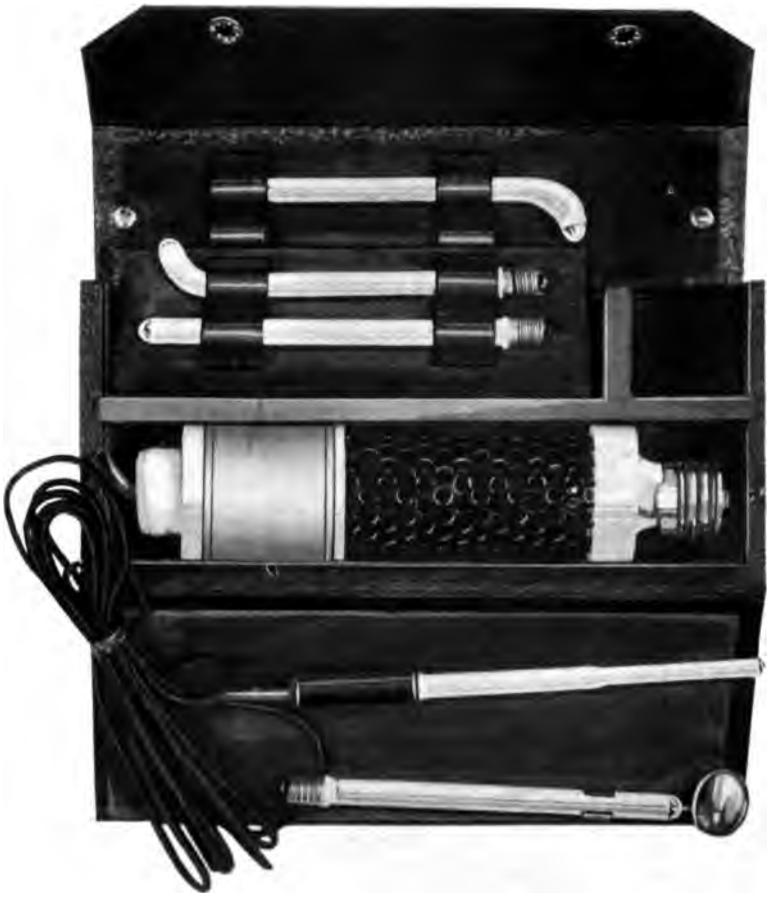


Fig. 499. Transilluminating lamp. (Designed by W. J. Cameron.)

There are a number of methods for entering the antrum which involve the nasoantral wall located in the region of the inferior and middle meatus, but the author will not attempt to discuss or give the technic of all the various methods, but will confine himself to the Canfield, Canfield-Ballenger, and Dahmer methods.

Since so many methods of operating have been presented to the profession, and the operative technic has undergone such a revolution within recent years, it is extremely difficult to ascertain to whom the various points of technic should be credited.

The technic of the different methods coming under this heading, as previously enumerated, will be given as clearly as possible, and any one of these methods *should be selected only in cases where the examination and history reveal a chronic condition of long standing and where the operator is confident that some of the simpler methods will not suffice, such as operating through the anterior wall of the antrum or by way of the alveolar process.*

Canfield's Operation.—Canfield deserves the credit for first presenting the technic of operating upon the antrum by entering the anterior angle of the apertura piriformis. This method consists of removing the bone of the anterior inferior wall of the antrum, and then elevating the mucoperiosteum situated on the median side of the inferior turbinate bone. The wall between the nasal cavity and the antrum is resected, leaving a flap of mucoperiosteum which is used at the conclusion of the operation to cover the floor of the antrum. The mucoperiosteum, which is situated on the lateral aspect of the inferior turbinate bone, is also elevated, facilitating an increase in the size of the flap and aids materially in securing sufficient tissue to cover the floor of the antrum. This method of operating will, undoubtedly, seem difficult to the reader, but when he has seen the operation performed the technic will appear very simple. It must be borne in mind that any operation, however simple, is difficult if the operator does not understand the technic of performing it. A feature worthy of mention with the Canfield method of operating is that a direct view of the sinus can be obtained through the nasal aperture, and a more

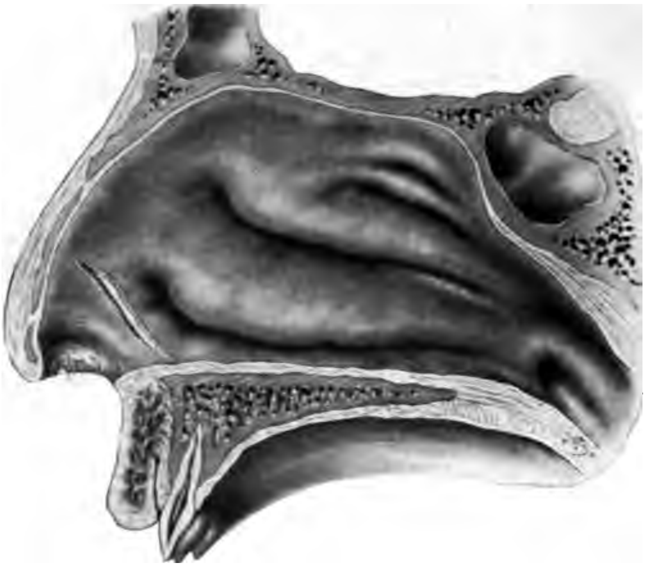


Fig. 500.—Canfield's operation. Incision. (Loeb.)

thorough curettement and treatment can be employed than by some other method, which makes it impossible to have such free access to the tissue located within the sinus.

Block anesthesia is easily accomplished in this operation, as in all others, if the operator makes the proper injections. After anesthesia is produced and the operation is started, if it is found there is considerable hemorrhage or oozing, a gauze or cotton pack saturated in 1/3,000 solution of adrenalin hydrochlorid is packed in contact with the tissue. If the operator has employed terminal anesthesia, in most cases it is not necessary to apply a pack containing the adrenalin hydrochlorid in order to produce ischemia, in view of the fact that the local anesthetic solution containing the adrenalin preparation has been injected into the tissue near the area of operation. Besides the pack containing the adrenalin hydrochlorid has been placed in contact with the mucous membrane covering the nasal side of the nasoantral wall and left in position for ten minutes, which will produce ischemia of the part. If the deep nerve blocking injections are employed, such as the second division by the intraoral route, it may become necessary to use the adrenalin pack to produce and maintain an area of ischemia at the site of operation. The operator should be positive that he has secured complete anesthesia before he attempts to operate, not only with this method, but any other method. If at any time during the operation he should notice that the patient is conscious of any pain, he should immediately stop and not proceed until complete anesthesia is secured. After complete anesthesia has been secured, the next step

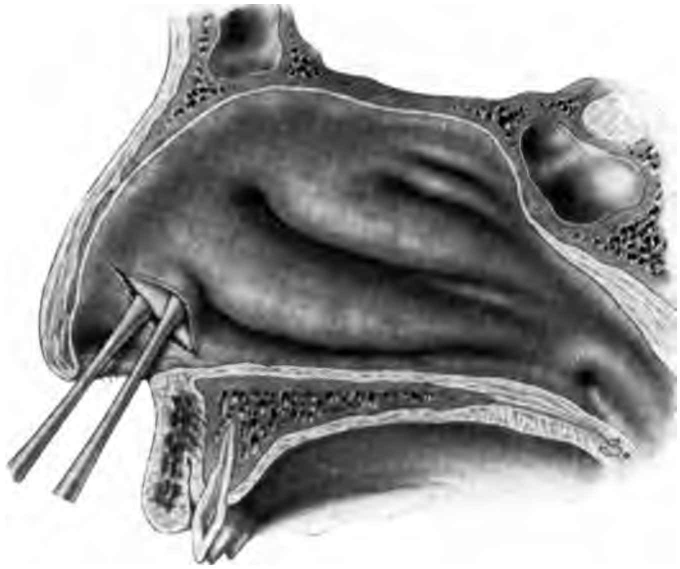


Fig. 501. Canfield's operation. Elevating the periosteum and soft parts from the facial surface and from the nasal wall of the maxillary sinus. (Loeb.)

is to make the initial incision, located one centimeter anterior to the inferior turbinate bone. A clean-cut incision should be made through all the tissues covering the anterior inferior angle of the anterior nares. (See Fig. 500.) Following the incision, the mucoperiosteum is elevated; the periosteal elevator is inserted in the incison, and it is forced laterally between the periosteum and the bone forming the anterior surface of the antrum, extending laterally to the incision. (See Fig. 501.)

Care should be taken not to traumatize the tissues while using the periosteal elevator. After a considerable amount of the mucous membrane and periosteum is separated from the bone around the point of incision, the next step is to gently carry the periosteal elevator backward and separate the mucoperiosteum from the nasoantral wall along the inferior meatus. After the mucoperiosteum has been treated thus far, the next step in the technic is to enter the antrum by removing the anterior inferior angle forming the nasal aperture. This bone, which forms the apertura piriformis, is very dense, therefore yields with great difficulty, and the operator can either remove it with the electric engine with the proper shaped bur, or with a trephine or chisel. The opening should be extended laterally along the bone which forms the anterior wall of the antrum to allow a thorough view of the sinus. By extending the incision or opening in the bone laterally on the anterior surface of the maxilla, it enables the operator to carry out a more efficient postoperative treatment. (See Figs. 502 and 503.) After the sinus has been entered on the anterior surface, the next step is to remove a portion of the thin bone which separates the sinus from the nasal cavity. This is easily accomplished by the use of the electric hand piece with bur, biting forceps, or chisel. This bony wall is removed back to an extent at least midway of the antronasal wall, but in some cases it is better to go even farther posteriorly than this location. In removing the bone which separates the antrum from the nasal

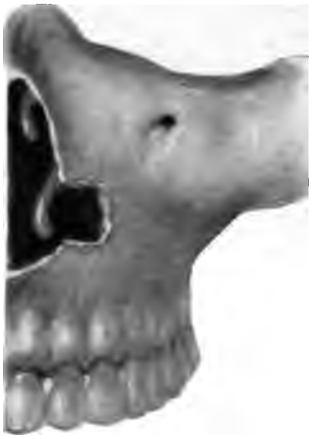


Fig. 502.—Bone removed in the Canfield operation. (Loeb.)

cavity, whether it is being done by the use of dental burs, forceps or a chisel, care must be taken not to injure the delicate nasal mucosa which is to be utilized to good advantage later. The next step in the technic is to give the interior of the antrum a thorough examination, and, if deemed necessary, curettage is done.

Following the curettement, the nasal flap is carefully placed over the floor of the antrum. (See Figs. 503 and 504.) This flap is now held in position by packing the sinus very loosely with iodoform gauze. The first gauze should remain in position for twenty-four hours, then be removed and a fresh supply placed in position. Excellent results are obtained in treating these cases with iodized gauze following the first iodoform gauze pack. The iodized gauze is prepared by submerging it in a 3½ per cent solution of tincture of iodin, and then thoroughly wringing it out. This is packed loosely into the sinus, carefully covering the mucoperiosteal flap on the second day following the operation. Iodin is not only an efficient antiseptic, but stimulates tissue repair, which is very desirable in these cases. Some operators advise the use of a gauze pack which has been saturated in a solution of the compound tincture of benzoin. It is always advisable for the patient who has undergone the radical type of operation, to remain in the hospital for a few days, or until the operator deems it advisable for him to go home.

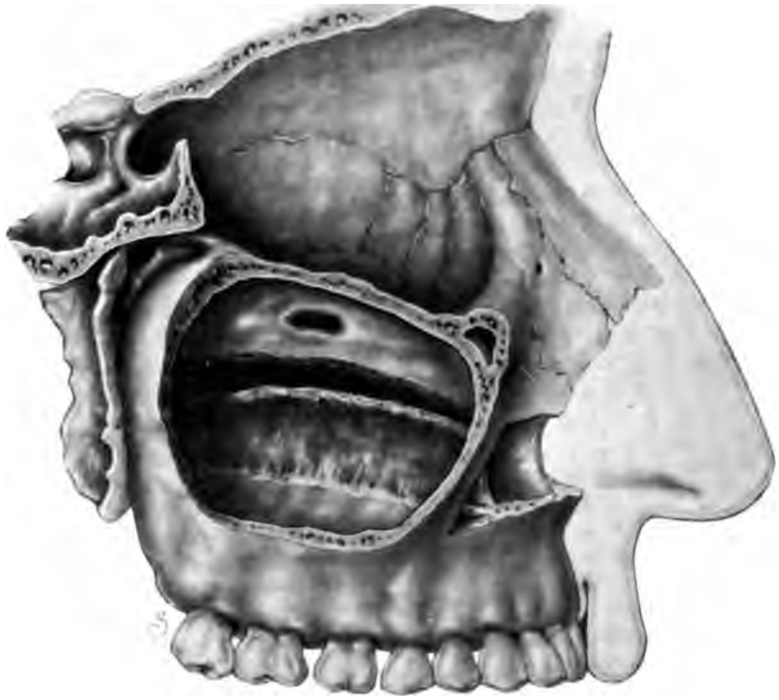


Fig. 503.—Canfield's operation. Diagrammatic illustration of using the flap from the nasal wall. (Loeb.) (Outer wall removed in order to show flap.)

In most cases, if the gauze pack is employed, it is changed in twenty-four hours and reapplied as deemed necessary. If at any time during the post-operative treatment the presence of pus is detected, the sinus should be irrigated with a weak solution of tincture of iodin, a ½ per cent Carrel-Dakin solution or a Ringer solution, at a temperature of approximately 105° F. After the patient is discharged from the hospital, he should be asked to return to the office at least every other day for examination. It is well to remember that in severe cases in which curettage was necessary to remove polypoid or granular tissue, considerable time is taken for regeneration of the tissues, and that the newly formed membrane is of modified type, consisting principally of fibrous tissue which may secrete a semipurulent fluid for some time. If extensive curettage was not necessary, and upon examination of the interior of the antrum the mucous membrane was found hyperemic and edematous, the tissues will return to normal in most cases very quickly. In those cases where the mucous membrane is not curetted, but is in a swollen, hyperemic and edematous state, many times excellent results are obtained by flushing with one of the above solutions. If the tissues are yielding to treatment, the mucous membrane will begin to resume its normal color. (Figs. 503 and 504 show the Canfield operation, the antronasal flap, etc.)

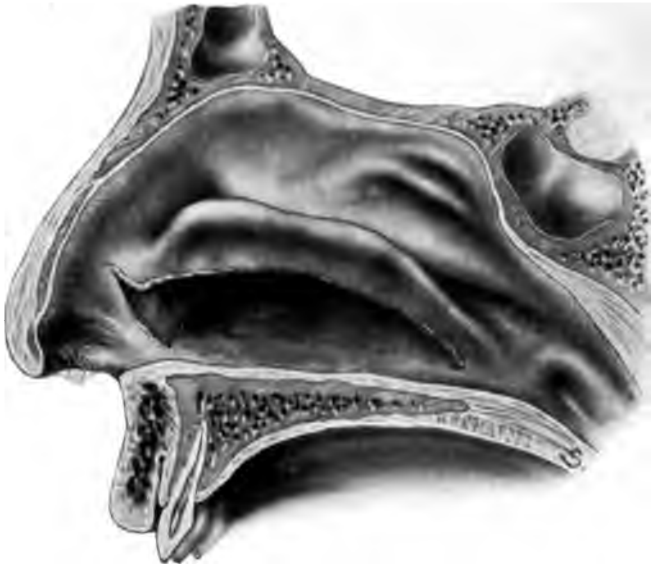


Fig. 504. Canfield's operation completed. (Loeb.)

Canfield-Ballenger Operation.—The Ballenger method of operating differs only slightly from that which was originally described by Canfield. Canfield first described this method, but later modified it by advising the removal of the anterior half of the inferior turbinate bone, and extending the incision into the tissue involving the middle meatus. The author does not see the necessity of extending the incision into the tissue involving the middle meatus, or the removal of the anterior portion of the inferior turbinate, only in exceptional cases. However, if the inferior turbinate bone is greatly enlarged, or is affected by disease, then it is advisable to remove it. But if the inferior meatus is normal in size, in the opinion of the writer, it is not only unnecessary to remove the bone, but it makes a larger opening into the nasoantral wall than is necessary. The Canfield operation can be performed without involving the inferior turbinate bone and, as previously stated, if conditions do not warrant it, it is far better not to include the inferior turbinate or middle meatus, as the removal of the nasoantral wall in the anterior region of the inferior meatus would in most cases answer all requirements.

The first step in the technic is to distend the nares with a nasal speculum, and then with a scalpel make the incision one centimeter anterior to the inferior turbinate. (See Figs. 505 and 506.) By the use of the nasal speculum, the anterior angle of the nasoantral wall is brought into full view. The incision is extended through all the tissues to the bone. Now use a periosteal elevator to raise the mucoperiosteum. The incision should be made over the entire length of the margin of the piriform aperture. When the mucous membrane and periosteum are elevated laterally and above the point of incision, care must be taken not to go too high, as there is some danger of injuring the branches of the infraorbital nerve. However, if the periosteum is carefully separated from the bone covering the anterior wall of the antrum, little hesitancy may be felt in this regard.

The next step in the operation is to open the antrum by going through the nasoantral angle, which can be easily accomplished by the chisel or dental engine and the hand piece equipped with the proper burs. After a small opening has been made into the antrum through the nasoantral angle with either the chisels or burs, the Wagner forceps are then employed to enlarge the opening. (See Fig. 508.) The opening is extended laterally over the anterior surface of the antrum to allow a direct view of the interior of the sinus. (See Fig. 507.) It will be noted from the illustrations that the initial incision was extended somewhat higher than the attachment of the inferior turbinate bone. Care should be taken not to remove any of the nasoantral wall above the attachment of the inferior turbinate bone, but it should be removed below this point. For thorough examination of the interior of the sinus and for postoperative treatment, it is only necessary to remove the anterior wall of the antrum to an extent of 1½ cm. laterally to the initial incision which gives ample room to complete the operation. The operator should not remove any more of the anterior wall of the superior maxillary bone than is absolutely necessary. After the opening has been made at the nasoantral angle, the next step is to remove the nasoantral wall. It will be found that the most efficient appliances for removing the nasoantral wall are the Wagner forceps, and burs. (See Figs. 491 and 508.) Great care should be exercised not to remove the bone too high; in other words,

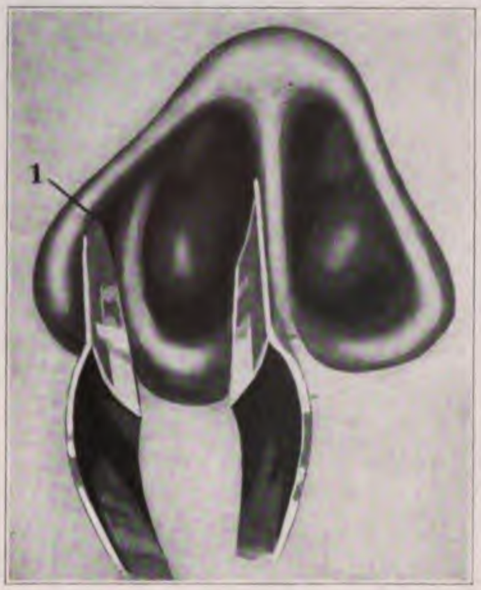


Fig. 505.—Canfield-Ballenger operation; 1, the margin of the pyriform aperture, the point of incision for the Canfield-Ballenger antrum operation.

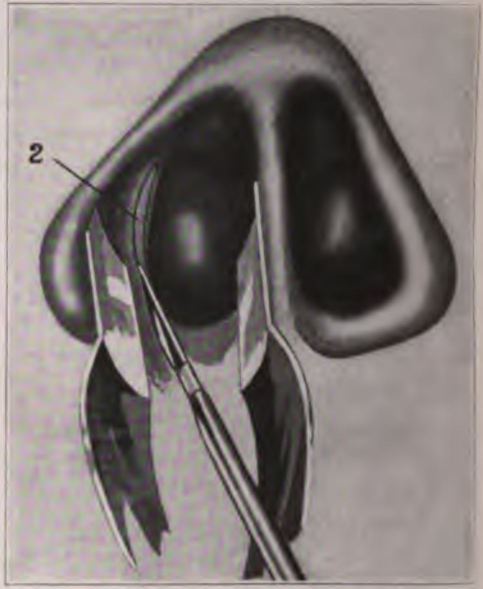


Fig. 506.—Canfield-Ballenger operation; 2, the incision.

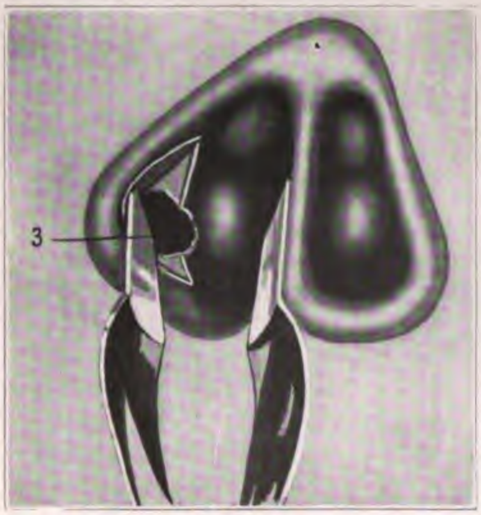


Fig. 507.—Canfield-Ballenger operation; 3, the nasoantral angle removed, thereby exposing the cavity of the antrum.

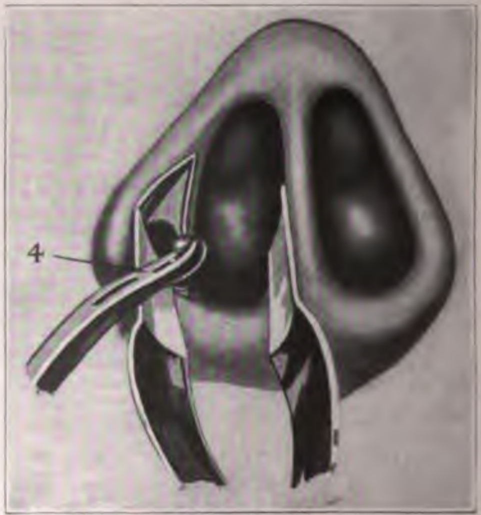


Fig. 508.—Canfield-Ballenger operation; 4, the nasoantral wall being severed with the Wagner forceps. (Modified from Ballenger.)

not to remove the bone which connects the inferior turbinate to the nasoantral wall. Unless the operator has had much experience in operating in the nasal cavity with burs in an electric hand piece, no doubt he can remove the nasoantral wall beneath the attachment of the inferior turbinate bone much better with a Wagner forceps. These are placed over the wall, and it is bitten away to a point midway between the anterior and posterior surfaces of the inferior turbinate.

The reader will note by comparing the Canfield and the Canfield-Ballenger operations that Canfield advises the preservation of the mucoperiosteum covering the bone situated in the region of the inferior meatus. Should the inferior turbinate bone be removed, as advised by Canfield, all of the mucoperiosteum is retained to be used in the floor of the antrum, while Ballenger advises the entire removal of not only the bone in the region of the inferior meatus, but also the mucous membrane and periosteum covering that part of the bone. The author advises the retention of the mucous membrane and periosteum covering the nasoantral wall. This can be carefully placed inward over the floor of the antrum, which is much better than cutting it away in its entirety. The inferior turbinate bone should also be spared, unless the existing conditions absolutely demand its removal. It is a question not to be argued that, if the inferior turbinate bone can be left in position and unmolested, it is far better to leave it than to remove it, because it performs a function in respiration.

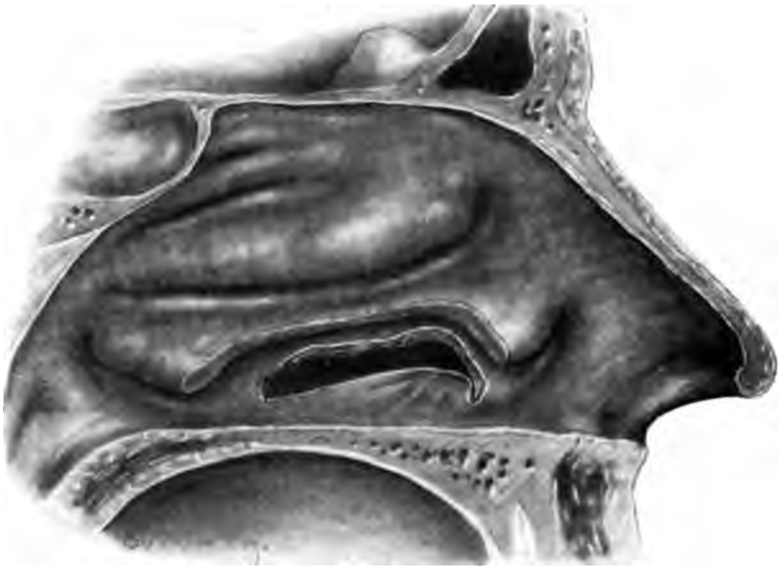


Fig. 509. Dahmer's method of using a nasal flap for the floor of the maxillary sinus. (Loeb.)

The postoperative treatment is similar to that already given under the Canfield method.

Dahmer's Operation.—Dahmer's method of operating is somewhat similar to the Canfield or the Canfield-Ballenger method, with the exception that in the Dahmer method the nasoantral angle is not involved; i. e., the bone is not removed on the anterior surface of the superior maxillary bone. The operation is confined to the nasoantral wall in the region of the inferior meatus. After complete anesthesia of the nasoantral wall has been secured, the anterior half of the inferior turbinate bone is resected. An incision is made through the mucoperiosteum posteriorly, superiorly and anteriorly, and the mucoperiosteum is then separated from the bone with a periosteal elevator, the operator being very careful not to cause laceration of the pedicle which is located posteriorly. The flap of mucous membrane located in the inferior meatus is folded outward over the antrum (Fig. 509). After this quadrilateral piece of mucous membrane has been carefully separated from the bone, the nasal wall in this region is perforated and removed with the various instruments which have been described with the other operations. (See Fig. 510.) After this has been accomplished, the interior of the antrum is illuminated and examined, and if the mucous membrane is found to be granular, and polypoid growths are present, it is treated by proper curettage and by the use of an efficient caustic. The nasal flap is carefully placed over the floor of the antrum as far as it will extend and iodized or iodoform gauze is packed loosely into the sinus through the nasal cavity to hold the flap in position. The gauze is changed from day to day, until in the operator's judgment, it is no longer necessary. Great care should be taken not to displace the flap in removing the gauze. An efficient instrument should be placed through the nasal cavity over the flap thus holding it down while the gauze is being removed.

The postoperative treatment is similar to that already given under the Canfield method.

POSTOPERATIVE RESULTS FOLLOWING MAXILLARY SINUS OPERATIONS BY THE INTRANASAL ROUTE

In many cases good results may be obtained by operating upon the maxillary sinus by the intranasal route, unless the case is a very obstinate one, the disease having extended over a period covering several years. It should be remembered that postoperative complications may occur, which are as follows:

1. If the operation performed includes the nasoantral angle, and a portion of the anterior wall of the antrum, prolonged anesthesia may be present in the central and lateral incisor teeth, gum tissue and alveolar process in this region. This is caused by interference with the nerve supply.
2. Following extensive curettage of the antral mucosa, abundant polypoid growths and granulations may occur.
3. Following extensive curettage of the nasal mucosa and the regeneration of the modified mucous membrane, which consists principally of connective tissue, an extensive exudate may be produced.

4. The formation of crusts, caused by the coagulation of blood, accumulation of pus and exudate, may in some few cases be present.

5. Following the operation, which involves considerable tissue, there may be considerable swelling and inflammation. However, this should be viewed in the light of tissue reaction following trauma, and is the natural inflammatory process which is present in regeneration. In case extensive inflammation and swelling are present, the operator must see his patient often and irrigate the part, if necessary, and see that it is kept clean and free from debris. If it is impossible to do this without inflicting pain, block or terminal anesthesia may be employed.

EXTRANASAL ROUTE OF ENTERING THE MAXILLARY SINUS

There are several methods for entering the maxillary sinus by the extranasal route. They are:

1. Kuster's method.
2. Caldwell-Luc's method.
3. Denker's method.
4. Alveolar method.
5. Author's method.

Kuster's Method.—The credit for first presenting the plan of opening the antrum through the cuspid fossa belongs to Kuster. This method is favored by many operators because the cavity of the antrum is fully exposed, thereby permitting thorough inspection and curettement. After complete block anesthesia has been established, the part is made as nearly aseptic as possible by the application of tincture of iodin, followed by 10 per cent alcohol.

The first step in the operation is to elevate the upper lip and make a horizontal incision one and a half inches in length along the labio-gingival junction, just above the apices of the teeth and carried through the mucous membrane and periosteum to the bone. The anterior part of the incision, as a rule, is made above the apex of the cuspid or over the apex of the lateral incisor and is extended distally parallel to a line drawn along the apices of the roots of the upper teeth. In most cases it will be sufficient to extend the incision distally to a point midway between the upper first and second molars. After the incision is made, a periosteal elevator is employed to elevate the mucous membrane and periosteum, due care being exercised in separating it from the bone so as not to injure the infraorbital nerve or any of its branches. The flap is carefully resected upward over the cuspid fossa, and the upper lip is elevated toward the eye with a retractor. After this has been accomplished and the anterior wall of the antrum thoroughly exposed, the sinus should be entered with a chisel or bur, and then the opening can be easily enlarged with a Rongeur bone forceps. The anterior wall of the antrum in most cases is limited to the thin bone situated above and distal to the cuspid fossa, and care should be taken to make the opening large enough to allow thorough examination and treatment of the interior of the sinus. In the average case it will be found that if the opening is of a diameter large enough to admit the index finger, or two centimeters, it will be of ample size. By the use of the illuminating lamp or the head mirror, the antrum is illuminated and all parts of it are examined. (See Fig. 499.) Upon examination, if polypoid growths or extensive granulation tissue, or necrotic areas are found, they should be immediately removed by thorough curettage. The antrum should be thoroughly explored with a probe and all pathologic tissue removed. The operator should use due diligence in determining the amount of tissue to be removed. If any necrotic bone is found, it should be immediately removed; however, the operator should not be too hasty in removing suspicious tissues and should not remove too much. In some chronic cases the antrum is divided by septa, thus converting the sinus into two or more cavities. If such septa are found they should be removed, converting the sinus into one large cavity. The sinus should be loosely packed with iodoform gauze, or gauze that has been dipped and wrung out of iodin solution, or gauze saturated with compound tincture of benzoin. Care should be taken not to pack the antrum under pressure, and the end of the gauze should extend through the incision at the labiogingival fold. It not only drains the antrum of any pus or excretions, but also prevents closure of the wound before the tissues of the antrum have yielded to treatment. In case considerable suppuration is present, the patient should be seen each day, the gauze packing removed and renewed. After

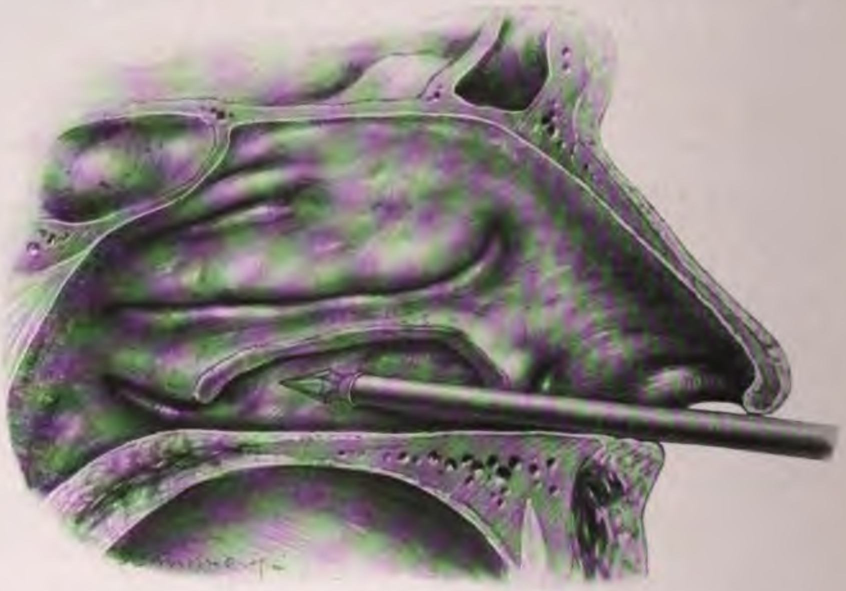


Fig. 510.—Penetrating the nasal wall of the antrum by Dahmer's method. (Loeb.)

removing the gauze, the antrum should be thoroughly irrigated with a ½ per cent Dakin's solution which has been freshly prepared, a weak iodin solution, or a Ringer solution.

The Caldwell-Luc Method.—This operation is preferable to the Kuster operation if the condition is chronic and a large amount of tissue is involved. However, more patients are operated upon by the Kuster method with good results, because we do not meet many cases of such a chronic character that they will demand the Caldwell-Luc operation. This method of operation is somewhat similar to the Kuster operation, but in addition to making an opening through the anterior wall of the superior maxillary bone into the sinus, resection of the nasal wall is also made. The operator should remember just what tissues are involved, the extent the operation covers, and the nerve blocking injections which are necessary.

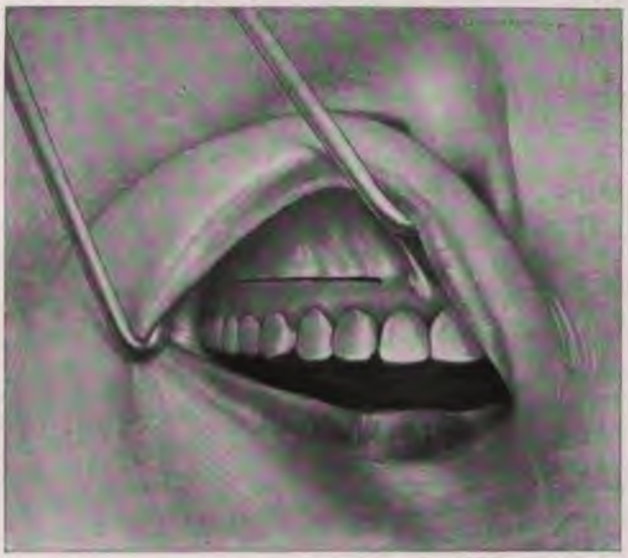


Fig. 511.—Caldwell-Luc operation on the maxillary sinus. Incision. (Loeb.)

The first step of the operation is to render the mucous membrane and gum tissue, lip and other adjacent structures, as nearly aseptic as possible through the application of tincture of iodin. Profound block anesthesia should be secured before attempting to operate. The initial incision is made just above the apices of the upper teeth at the labiogingival margin. The anterior portion of the incision is located above the apex of the lateral incisor and is extended distally parallel to the apices of the upper molar teeth to a point midway between the roots of the upper second and third molars. The incision should extend through the mucous membrane and periosteum. Th incision is somewhat longer than that made by the method previously described. (See Fig. 511.) After making the incision, with a periosteal elevator carefully separate the mucoperiosteum from the bone situated in the cuspid fossa laterally over the anterior surface of the superior maxillary. Care should be exercised not to traumatize the tissue or injure the infraorbital nerve or its branches. The bone having been exposed, the next step is to enter the antrum with the dental bur, chisel or trephine. The bone may be removed by burs, bone forceps or chisels. (See Fig. 512.) The size of the opening depends a great deal upon the extent of the pathological condition. If there is considerable involvement, it is well to extend the opening from the anterior extremity of the antrum to a point below the malar process and upward from the alveolar margin to a point about one and a half centimeters beneath the infraorbital margin. Great care should be taken when extending the incision upward so as not to injure the infraorbital nerve or its branches. (See Figs. 513 and 514.) In addition to the opening into the sinus through the anterior surface of the superior maxillary bone, the nasal wall is also resected in the region of the inferior meatus, and in most cases a portion of the inferior turbinate is removed. (See Fig. 515.) In case it is deemed advisable to form a flap of the mucous membrane covering the inferior turbinate and the bone in the region of the inferior meatus, it can be easily done, and this flap can be extended over the floor of the antrum, as has been described, with other types of operations. After proceeding thus far with the operation, make a thorough examination of the interior of the antrum with an illuminating lamp, and if the mucous membrane lining the cavity has under-

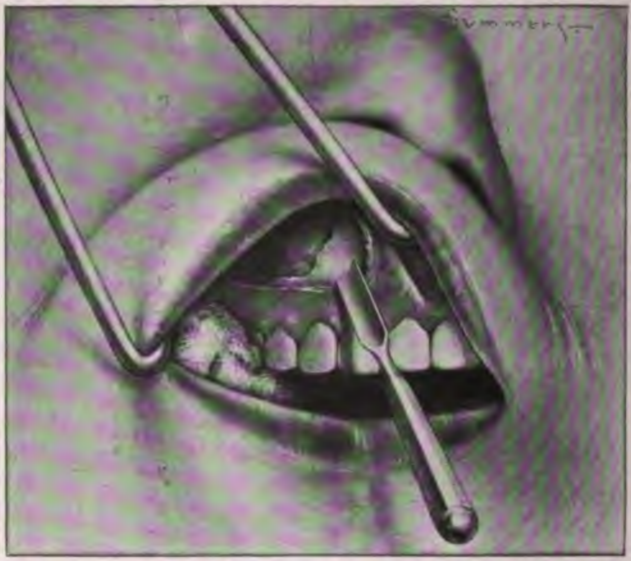


Fig. 512.—Caldwell-Luc operation. Chiseling the facial surface of the maxillary bone. (Loeb.)

gone considerable degeneration, such as extensive granulation, thorough curettage should be done. The floor of the antrum should be carefully examined, and if the ends of the roots show infection or if there is necrosis of the bone, it should be removed. The condition of the teeth should also be carefully considered, for in many cases their removal is necessary. The nasoantral flap of mucoperiosteum is used in the floor of the antrum, the tissue being carefully separated with the periosteal elevator, as has been described. The anterior half of the inferior turbinate bone may be resected, or it can be left intact and not molested. This will depend upon the involvement of the tissues. The bone of the inferior meatus is removed by bone forceps or burs, as described above under other methods of operating on the antrum. In case the nasal flap is employed, it is carefully placed over the floor of the antrum and iodoform or iodized gauze is packed loosely into the sinus and a portion of the gauze allowed to extend through the inferior meatus into the nasal cavity to act as a drain. (See Figs. 516 and 517.) The first gauze dressing should remain in place for at least forty-eight hours, then be carefully removed and replaced. After the gauze is removed, if suppuration is present, a ½ per cent Carrel-Dakin solution, iodin solution, or Ringer solution, may be used to irrigate, and the iodized gauze or iodoform gauze can be replaced if necessary. This method of operation should be used only in extreme cases in which there is pronounced suppuration, granulation tissue, polypi, or necrosis.

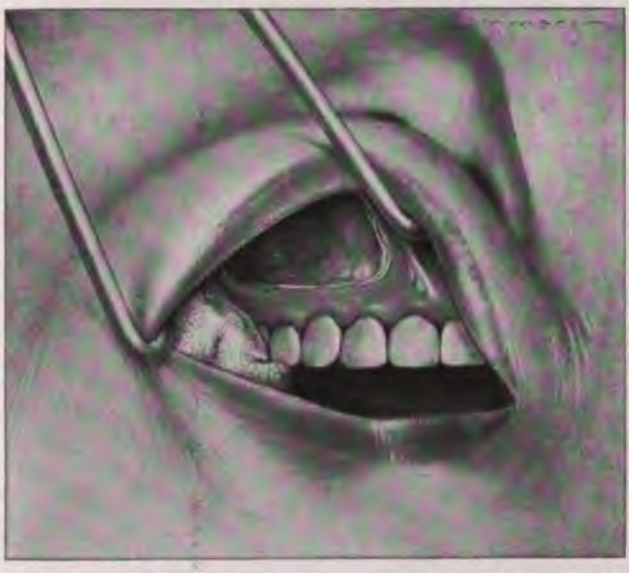


Fig. 513.—Caldwell-Luc operation. Bone removal completed. (Loeb.)

The Alveolar Method.—For many years the alveolar method of operating for maxillary empyema was a popular procedure. In the past, and even at the present time, many operators select this method for the reason it is an extremely easy way to enter the sinus and because it gives quick relief to the patient. The procedure was to remove the offending tooth, usually the second bicuspid or first molar, and then to enlarge the alveolus so the cavity of the antrum could be reached. If it is found absolutely necessary to extract the carious tooth, where there is every reason to believe it is the source of infection, very good results can be obtained by treating the infected antrum through the socket, but a tooth should never be sacrificed unless it is in such a pathologic condition that its removal from the mouth would ben-

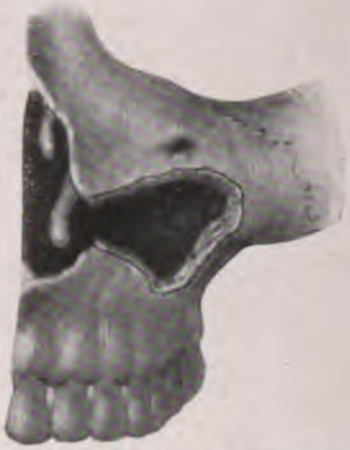


Fig. 514.—Cavity shows bone removed in the Caldwell-Luc operation. (Loeb.)

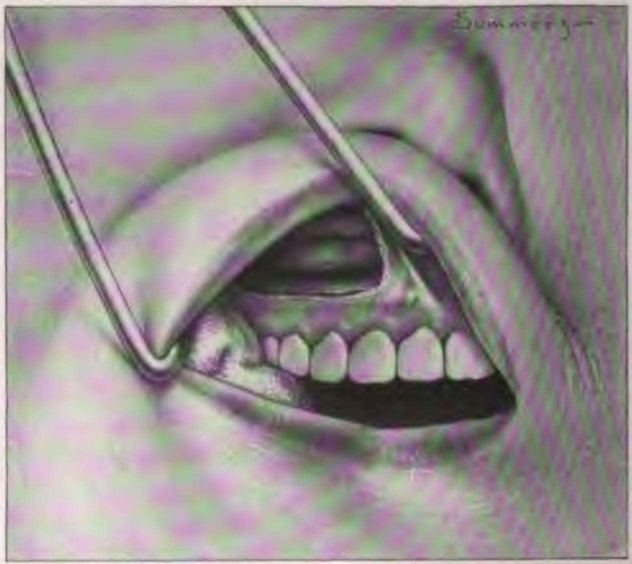


Fig. 515.—Caldwell-Luc operation. Nasal wall removed. (Loeb.)

efit the patient. There are four good reasons why a useful tooth should not be extracted to treat maxillary empyema, and they are: First, the patient is sacrificing a tooth which is of great value. Second, after a tooth has been removed, it may be found that septa are present, thus dividing the antrum into two or more compartments, and if this condition exists, it is difficult to obtain free drainage unless a large opening is made. Third, in case the opening through the alveolar socket into the antrum is of small diameter, much trouble may be experienced in keeping the opening patent. On the other hand, if it is made

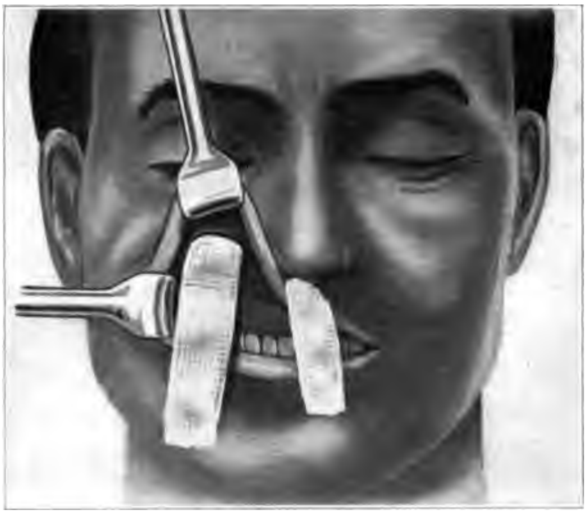


Fig. 516.—Applying the gauze dressing through anterior wall of antrum and inferior meatus. (Modified from Ballenger.)

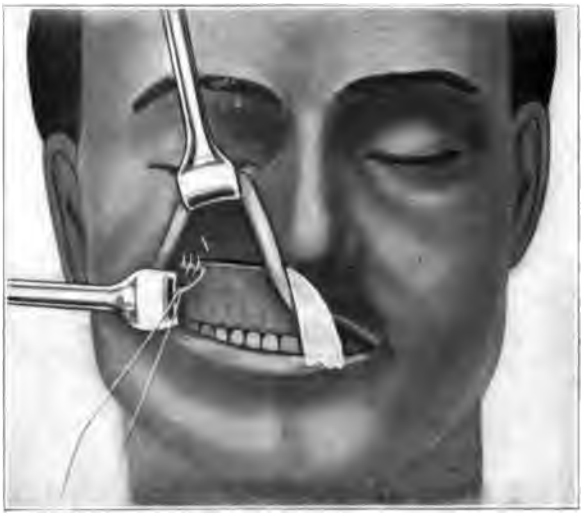


Fig. 517. Closing incision following application of gauze dressing. (Modified from Ballenger.)

quite large, there may be considerable difficulty experienced in getting the alveolus to close, due to the larger opening in the alveolar process and the absence of soft tissue. Fourth, it is impossible to observe and explore the interior of the antrum with as much ease and certainty, as when the sinus is entered through the wall of the antrum, or by some of the other methods which are elsewhere described.

In the writer's opinion a tooth which possesses any physiologic importance should never be sacrificed, but if the tooth must come out, the alveolus can then be enlarged by proper curettes or by using the dental engine with a proper sized bone-cutting bur. (See Fig. 518.) If the osseous tissues are diseased, they should be removed down to firm tissue; at least, the opening should be equal to the mesio-distal diameter of the tooth removed. All diseased areas should be thoroughly curetted, and useless destruction of the buccal or lingual margins of the bone should be guarded against. The gum flap should be preserved also to insure the final closing of the cavity.

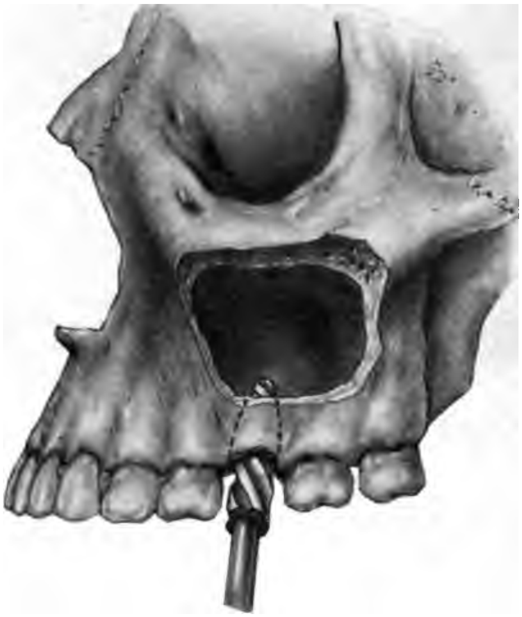


Fig. 518.—Operation through the alveolus. (Loeb.)

After the antrum has been entered, a careful examination should be made with a straight and right-angled curette, and the antrum lamp may be used to advantage for the purpose of illuminating the interior of the cavity for a thorough examination. The small diameter of the antrum lamp permits it to be passed through the opening of the alveolus to the floor of the antrum. (Fig. 499.) If pus is present, the antrum should be irrigated as often as deemed necessary with one-half per cent Carrel-Dakin solution, Ringer solution or permanganate solution, at a temperature of approximately 105° F. After irrigation, a strip of iodized gauze or one which has been saturated with a compound tincture of benzoin is packed loosely in the socket, allowing a few inches of it to be forced through the opening on the floor of the antrum. In a few days, it may be advisable to cover the opening with a gold or vulcanite cap to prevent too rapid closure and to guard against saliva and food passing through the opening into the sinus and causing reinfection. The socket should be kept packed, thus protecting the interior of the antrum until the operator is sure the opening has closed at the antral floor. Excellent anesthesia can be produced by blocking the second division of the fifth nerve by the intraoral method. By blocking the second division of the trigeminus, it will eliminate all sensation in the highly sensitive mucous membrane located in the floor of the sinus, teeth and osseous structure.

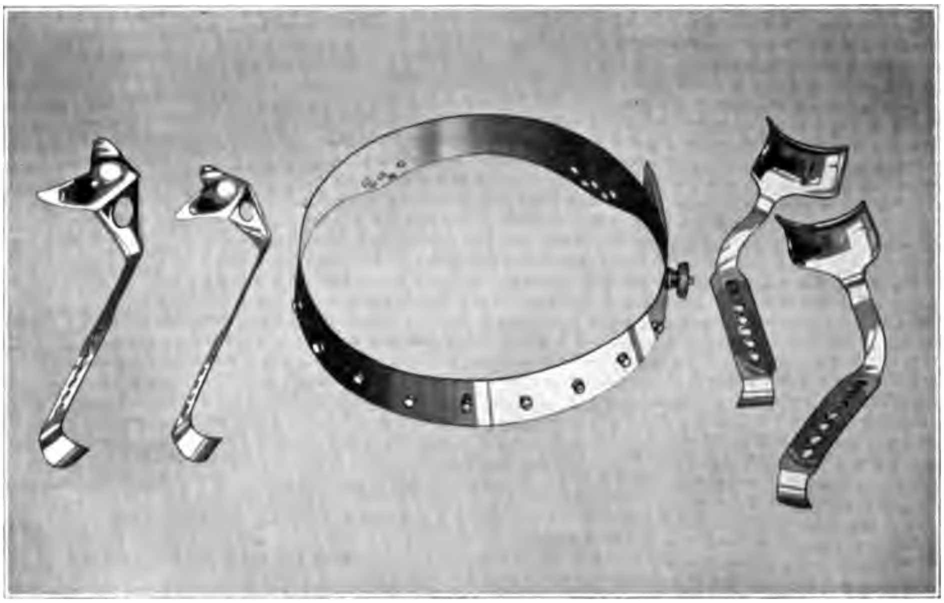


Fig. 519.—Headband and retractors. (Suggested by Dr. F. B. Moorehead.)

Author's Method.—The technic employed by the author for operating and treating maxillary sinus disease for cases which do not demand radical operation, is as follows: Make a thorough examination and obtain a complete history from the patient as to the time he first experienced pain in the region of the frontal sinus or orbit; also the time he first detected an abnormal condition, or the presence of pus from the nose. This should be supplemented with proper radiograms of the teeth and their relation to the floor of the antrum; also the condition of the process, if disease is present, as, for instance, pyorrhea. Dr. Bogle states that in some cases pus may be present, with no discharge from the nose, the pus being confined within the antral lining.

Anesthesia.—Anesthesia is produced in the upper jaw by blocking the second division of the fifth nerve as it crosses the sphenomaxillary fossa, by the intraoral method. If the injection is properly made, complete anesthesia is secured of all the tissues to be operated upon. (See page 380 for technic for blocking the second division by the intraoral method.)

Preliminary Preparation of Tissue.—The tissues of the mouth should be rendered as nearly aseptic as possible. The retractor with head band (see Figs. 519 and 520) is placed in position, the tissue drawn back, and the upper lip elevated to a considerable extent. Next, thoroughly dry the entire mucous membrane covering the anterior and lateral surfaces of the superior maxillary bone, from the median line as far posteriorly as the upper second or third molar. This tissue can be dried with sterile gauze held by artery forceps. Next apply to the surface a solution of tincture of iodin, after which care should be taken not to contaminate the tissue with saliva where the incision is to be made.

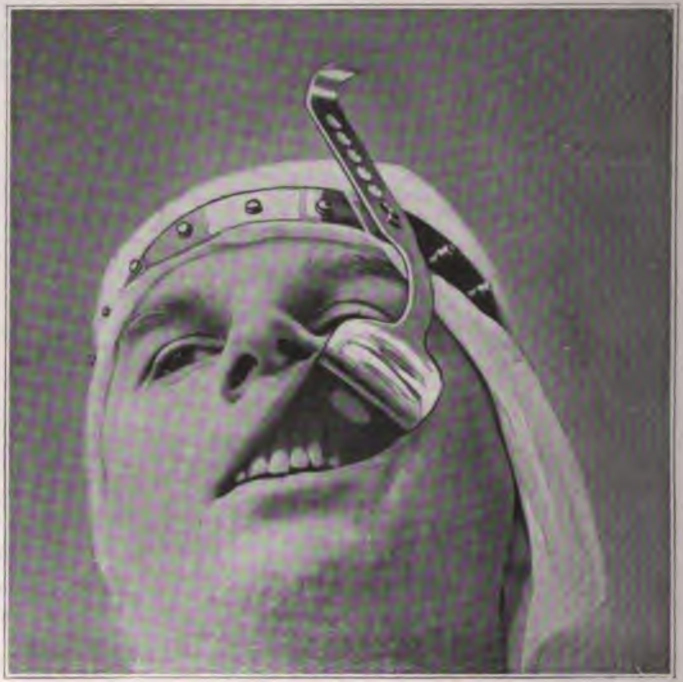


Fig. 520.—Headband and retractor in position. Area exposed above and posterior to cuspid for entering antrum through anterior lateral wall.

Technic of Operating.—The incision is made through the mucous membrane and periosteum to the bone just above the apices of the upper second bicuspid and first molar. The incision should be started above the apex of the root of the first bicuspid, extending it posteriorly and slightly downward, directing it to a point just above the apex of the root of the upper second bicuspid and then slightly upward and posteriorly, above and between the apices of the buccal roots of the upper first molar. (See Figs. 520 and 521.) The diameter of this incision will be approximately 20 mm. The flap end of the incision is located downward, while the pedicle or base of the flap is located upward. The posterior and anterior parts of the incision are extended upward from 15 to 20 mm. The periosteal elevator is now placed in the lowest part of the incision, and the mucoperios-

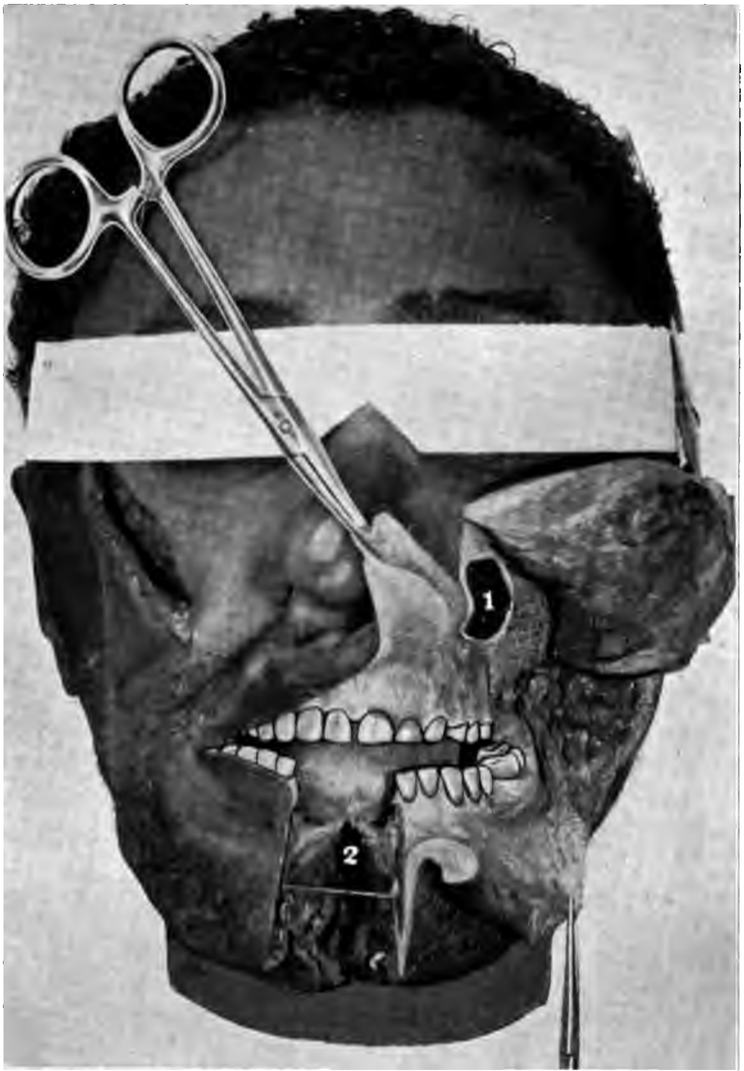


Fig. [illegible]. Wet anatomic specimen illustrating: 1, Opening into antrum through anterior wall; 2, mandible and soft tissues incised at medial line.

teum is carefully separated from the bone, extending the flap upward and being careful not to traumatize or lacerate the tissue. It will be found before making the incision that by injecting one mil of the local anesthetic solution in the immediate area of operation, the suprarenin contained in the injecting solution will produce an area of ischemia, thus lessening or entirely eliminating hemorrhage during the operation; or instead of injecting the solution, a small gauze tampon, saturated with 1/2000 solution of adrenalin and held firmly against the operative area for several minutes, may be employed. The flap is now carefully raised and the bone covering the anterior wall of the antrum fully exposed. Bone cutting burs, such as shown in Figs. 489-494, are used in the electric hand piece, and an opening is made through the thin bone just above the apex of the root of the upper second bicuspid. The opening is then enlarged by chisels, the Rongeur forceps or Wagner punch. (See Figs. 520 and 521.) An opening of approximately 2 cm. in diameter is carefully made, which is of ample size to allow a thorough examination of the interior of the sinus. A small electric diagnostic lamp, such as illustrated in Fig. 499, is now inserted through the opening, and the antrum is illuminated and examined. The flap should be carefully elevated and held by retractors. Care should be taken while extending the incision upward and while separating the mucoperiosteum from the anterior wall covering the sinus, not to injure the infraorbital nerve or any of its branches. Insert straight and right angle curettes for exploring. It will be found the safe edge loop curette is much better than the ordinary one for examining the interior of the antrum. The safe edge loop curette will not injure any of the mucous membrane, and if polypi are present, they can be readily detected. All granulations, polypi, and necrotic bone should be carefully removed. The loop curette is only of value for removing polypi, and if it becomes necessary to remove any diseased mucous membrane or necrotic bone, the spoon curette is employed. The floor of the antrum should be thoroughly examined. It should be noted whether or not the apices of the teeth extend through the floor, and if there have been any degenerative processes in the floor of the antrum surrounding the ends of the roots of the teeth. If the teeth are involved they should be removed.

Postoperative Treatment.—In some cases it is advisable to flush the antrum with a Ringer solution, a ½ per cent Carrel-Dakin or a 1 per cent permanganate solution at an approximate temperature of 105° F. Pack the antrum loosely with iodized gauze or gauze saturated with tincture of benzoin, leaving same for 48 hours. Redress as often as necessary using a smaller piece of gauze each time. If any suppuration is present, it is good practice to irrigate with one of the above named solutions. After forty-eight hours many cases will do better without packing. After the medicated packing has been discontinued, it is necessary to keep the opening from closing too quickly by inserting a small piece of gauze.

In many cases a Ringer solution is preferable to an antiseptic solution. Fig. 153 shows an all-metal syringe the author employs for irrigating the sinus. After operating in the manner previously described, if the case does not yield to treatment and proves to be very persistent and of a chronic nature, it may be necessary to operate by the intranasal method, such as the simple resection of the nasal wall in the region of the inferior meatus, using Dahmer's nasal flap method, the Canfield method, or the Canfield-Ballenger method. For a complete description of these operations the reader is referred to each under the respective headings.

CHAPTER XXX

BLOCK ANESTHESIA FOR THE RESECTION OF THE SUPERIOR MAXILLARY BONES; SURGICAL OPERATIONS ON LOWER JAW AND TONGUE

The resection of one or both superior maxillary bones may be done through the medium of nerve blocking. The credit belongs to Matas for first performing this operation under nerve blocking in 1900, at which time he completed the resection of both the right and left superior maxillary bones. The entire hard palate was removed.

The Gasserian ganglion may be blocked for this operation, but it is not necessary to do so, because good results can be obtained by other deep block injections. The second division of the fifth nerve is blocked just before it enters the posterior part of the orbit (see page 380). Blocking the second division is a very valuable procedure for surgery, as the nerve trunk is easily reached by the needle. The author does not advise blocking the second division of the fifth nerve through the orbit, for if this route is employed the solution must infiltrate a considerable distance from the point where it is deposited in order to anesthetize Meckel's ganglion. If the solution does not reach the ganglion, those branches which pass from it will remain sensitive, and pain will be inflicted when the operation is undertaken.

For the resection of one jaw, or the performing of any operation which involves tissue near the median line, it is necessary to block the interlacing branches near the median line by the terminal method. The interlacing or overlapping nerve branches of the right and left superior maxillary are abundant and must be blocked if the operation extends into this region. These branches are blocked by terminal injections, or by blocking the superior labial, lateral nasal, inferior palpebral, and anterior superior dental at the infraorbital foramen on the side opposite the operation. The first terminal injection is made by inserting the needle in the skin at the ala of the nose as illustrated by number 6 in Fig. 522. The needle is removed and reinserted at the margin of anesthesia, and the method repeated as often as necessary. In addition to the terminal injections to block the nerve branches near the median line, it is necessary to extend the injections laterally from the angles of the mouth to a point 2 cm. anterior to the lobule of the ear as indicated by dotted line number 4 illustrated in Fig. 522. Extend the line of injections upward, midway between the outer canthus of the eye and helix of the ear, then medially over the infraorbital margin of the superior maxillary bone. (See Fig. 522.) The object of these terminal injections is of a threefold purpose:

1. To anesthetize the terminal sensory fibers from the opposite side at the median line.

2. To anesthetize the nerve branches which arise from the third or mandibular division and extend into the operative field.

3. To produce an area of ischemia, thereby greatly reducing the amount of hemorrhage during the operation.

If only a part of one jaw is to be removed and the floor of the orbit is not involved, the following injections are made:

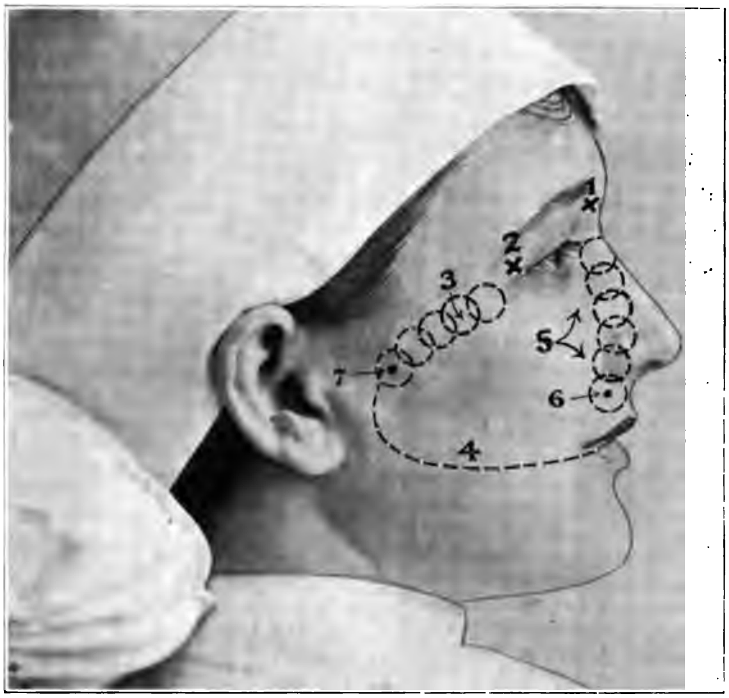


Fig. 522. Illustrating the facial injections for resection of superior maxillary bone.

1×, Location for medial orbital injection; 2, location for lateral orbital injection; 3, terminal circular injections; 4, line of circular injections from angle of mouth connecting with injections shown at number 7 to block overlapping branches from third division. This line also represents extent of anesthesia secured by the blocking of second division; 5, circular injections to block overlapping nerve branches from opposite side; 6 and 7, points for making initial injections.

1. Block the second or superior maxillary division of the fifth nerve by either the intraoral or extraoral method. (See page 380 for technic.) Inject four mils of a 2 per cent solution.

2. Block the anterior and posterior ethmoidal nerves by making an inner orbital injection. Inject three mils of a 2 per cent solution. See x, marked No. 1, Fig. 522 and page 375 for technic.

3. Terminal injections are made for the branches of the third or mandibular division and the overlapping fibers at the median line (see Nos. 4, 5, and

6 in Fig. 522). About ten insertions of the needle are necessary. Use one mil of a one per cent solution for each injection.

4. Block the nasopalatine nerves near the anterior palatine foramen. Inject one mil of a 2 per cent solution, unless the right and left second divisions of the fifth nerve have been blocked.

5. Block the anterior palatine nerves at the posterior palatine foramen. Inject one mil of a 2 per cent solution, (unless the right and left divisions of the fifth nerve have been blocked.)

6. Block the soft palate by infiltration at the line of incision if one side only is injected. Inject one mil of a 2 per cent solution.

The object of the last three injections is to block the nerve supply from the opposite side, but they are not needed if the second division of the trigeminus is blocked on both sides.

In case the operation involves the floor of the orbit, the outer orbital injection (see No. 2 in Fig. 522 and page 372 for technic) is made in addition to the above named injections. The approximate amount of solution injected, is 12 mils of a 2 per cent and 10 mils of a 1 per cent.

In 1900, when Matas employed nerve blocking and performed the first operation for the resection of both superior maxillary bones, he inserted the needle through the infraorbital fissure entering the spheno-maxillary fossa, and injected a small amount of a one per cent solution of cocain to anesthetize the second division of the fifth nerve. This injection was made on both sides. In addition to these two deep injections, he infiltrated the tissue comprising the hard palate and septum with Schleich's solution. Following these injections Matas performed the operation without pain. At that time, the drawbacks met in performing such operations were the toxicity of cocain and the absence of a vaso-constricting agent. The large amount of cocain solution, which was necessary to produce complete anesthesia, was very dangerous, as it was absorbed quickly, which not only increased its toxicity but caused sensation to return to the parts before the operation could be finished.

Since the isolation of the active principle of the suprarenal gland, together with the preparation of synthetic local anesthetics, which are less toxic than cocain, operations on the antrum, resection, etc., under nerve blocking anesthesia, have been placed upon a practical basis. If a complete unilateral resection is to be performed, which includes the floor of the orbit, it is necessary, in addition to blocking the second division of the fifth nerve to make the orbital injection. (See page 372 for technic.) However, if only a partial resection is to be done, which will not include the floor of the orbit, then it is not essential to make the outer orbital injection, as the blocking of the other nerve branches, previously outlined and numbered from 1 to 6, is all that is necessary. Instead of making the terminal injections previously described under No. 3, the third division of the fifth nerve may be blocked, or the inferior dento-lingual, at a point one centimeter above the occlusal plane of the lower teeth.

LOCAL ANESTHESIA FOR SURGICAL OPERATIONS UPON THE LOWER JAW

Almost any operation may be performed on the mandible or soft tissues of the lower jaw under local anesthesia, if the proper technic has been employed in blocking the nerve supply. The author has performed a number of operations involving considerable bone, and soft parts located in this region, under block anesthesia and the results have been highly gratifying. Operations for alveolar abscess, epulis, necrosis of the jaw, compound fractures, osteoma, cysts, polypi, ranula, etc., can in most cases be successfully performed under block anesthesia.

Hertzler is quoted with reference to surgery of the lower jaw as follows: "With care and experience these operations become astonishingly simple. Before attempting excision of the jaws, I hesitated lest the mental effect of the removal of the jaw would prove a source of shock, and this anticipation was not fulfilled. Patients bear the saw without complaint and speak as calmly with the tongue rolling out of the wound as though they were not being subjected to any unusual experience."

The tissues comprising the floor of the mouth and the mandible obtain their nerve supply from the third or mandibular division of the fifth nerve. If the operation does not involve the ascending ramus and is located on one side, as, for example, within the region of the lower molars and bicuspid teeth, the lingual and inferior dental nerves are blocked. However, if the operation is unilateral and involves the ascending ramus, condyle, and coronoid process of the mandible, and other tissues, then it becomes necessary to block the third division of the fifth nerve at the foramen ovale. (See page 525 for technic.) If the operation involves the tissues comprising the floor of the mouth, or the bone comprising the mandible anterior to the rami, then the right and left inferior dento-lingual injections are made. On the other hand, if the operation extends to the distal of the teeth, that is, involving the two rami and other tissues in that region, it is necessary to block the right and left mandibular divisions of the fifth nerve. (See technic page 525.) When the operation involves the tissues located intraorally, the previously mentioned injections are sufficient in most cases. However, if the operation involves the skin and muscle tissue, if the incisions are made from without, it becomes necessary to block the nerve branches arising from the cervical plexus. (Fig. 408 shows that several terminal injections have been made along the lower margin of the mandible.) These terminal injections by the circular method, combined with the blocking of the lingual and inferior dental nerves, or the blocking of the third division of the fifth nerve, are sufficient for reducing a fracture or the performance of other surgical operations, in the region of the mandible. The terminal injections will anesthetize the peripheral branches of the cervical plexus. Not only do the terminal injections block the nerves which enter the operative field, but the infiltration of the skin, muscle and connective tissue produces ischemia, thereby lessening the amount of hemorrhage. Under general anesthesia *operations of the major type* which involve the upper and lower jaws, gum tissue, teeth, and other structures are very difficult to perform under the most favorable circumstances. Two of the greatest obstacles the oral surgeon has to encounter are the interference of the mask, and to prevent blood from passing into the throat and trachea.

Another disadvantage of general anesthesia for operations of the major type in this locality is the possibility of postoperative complications, especially pneumonia. During the world war block anesthesia on extremely mutilated jaw and throat cases saved the lives of many who no doubt would have died from postoperative pneumonia following a general anesthetic.

The disadvantages of local anesthesia for operations of major type, such as resection of the upper or lower jaw, or for carcinoma of the tongue, are:

1 The patient's knowledge of what is taking place, and upon some patients it would be utterly impossible or impracticable to employ local anesthesia.

2. In some instances it may be impossible to block the operative area, without injecting a large quantity of the anesthetizing solution.

The writer desires to again place emphasis upon the necessity of the anesthetist or oral surgeon carefully selecting his anesthetic, and he must not be too hasty in favoring local anesthesia over general anesthesia, or vice versa. Both methods have their indications and contraindications, and when both are fully understood a greater service can be rendered than when only one method is employed.

LOCAL ANESTHESIA FOR MINOR OPERATIONS IN THE SOFT TISSUES FORMING THE FLOOR OF THE MOUTH

Local anesthesia can be utilized to advantage for operations in the floor of the mouth, such as for the removal of a benign tumor, ranula, draining an alveolar abscess, removal of necrosed bone, etc. In some cases the area can be blocked by surrounding the part with a local anesthetic. In case the terminal method of anesthesia is employed, insert the needle into the mucous membrane at a point distant from the pathological tissue, and inject the solution. This is repeated a number of times until the solution has been deposited around the entire area. (See circular or regional method, pages 648, 673, and 674.) After the solution has been injected in a circular fashion, use a long fine needle and insert it beneath the pathological area in three places and inject a quantity of the solution. (See Fig. 473.) In addition to the terminal injections, it is necessary to block the lingual nerve. If there should be pus in the tissue of the oral cavity, it is not advisable to make the intraoral injections, and the extraoral method should be employed. The lingual nerve can be blocked according to the method of Thoma, by inserting the needle to the lingual of the angle of the ramus, directing it upward and slightly anteriorly to a point one centimeter anterior to the lingula. (See Figs. 411 and 412.) In addition to the blocking of the lingual nerve by the extraoral method, several terminal extraoral injections are made by inserting the needle lingually to the border of the body of the mandible and extending it upward along the lingual periosteum covering the bone. For example, if the operation involves the floor of the mouth, covering an area extending from the first bicuspid to the second molar in the lower jaw, then the needle would be inserted at the lower inner border of the body of the mandible distal to the second molar, where at least two mils of a two per cent solution are injected. The needle is now withdrawn partially, but without taking it out of the tissue it is directed anteriorly and forced upward along the lingual periosteum lingual to the position occupied by the second bicuspid, where two more mils of the solution are injected. The needle is again withdrawn, but without taking it out of the tissue, its direction is changed and forced upward along the lingual periosteum lingual to the position occupied by the first bicuspid, where two mils of the solution are injected. Following this technic the solution has been distributed along an area extending from the mesial surface of the first bicuspid to the distal surface of the second molar, with only one puncture of the skin. If a large benign tumor or cyst is located in the anterior part of the floor of the mouth near the side of the frenum of the tongue, the lingual nerves are blocked on both sides at a point one centimeter above the occlusal plane of the lower teeth, and in addition the needle is inserted in the skin to the lingual of the inferior border of the mandible near the symphysis. The needle is inserted directly upward and in contact with the periosteum in the region of the genial tubercles, and when it reaches a point just beneath the involved tissue, two mils of the solution are injected. The needle is now retracted without being taken out of the tissue, its direction is changed, diverting it laterally to a region lingual to the cuspid tooth. Two more mils are injected. Again the needle is retracted without taking it out of the tissue, and a like injection is made on the opposite side. In all, six mils of the solution have been injected, and only one puncture of the skin has been made. In addition to the six mils which have been injected for the terminal injection, the two lingual nerves have been blocked, each requiring two mils of the solution; therefore, the total amount of solution injected is ten mils.

BLOCK ANESTHESIA FOR OPERATIONS UPON THE TONGUE

Operations upon the tongue may be performed under block anesthesia in which a limited amount of tissue is involved. The anterior two-thirds of the tongue can be quickly anesthetized by making a block injection into the lingual nerves described on page 570. If there is any reason why the lingual nerves should not be blocked at a point one centimeter above the occlusal plane of the lower teeth, they can be easily blocked lingually to the alveolar plate covering the lower third molar. At this point the nerve is near the periosteum; if one projects a line from the buccal surface of the lower third molar to the angle of the inferior maxillary bone, the lingual nerve crosses this line at a point one centimeter below the lingual surface of the lower third molar. However, blocking the lingual nerve at this point offers nothing in the way of superiority over blocking the nerve at a point one centimeter above the occlusal plane of the lower teeth. In case the operation should only involve the lateral half of the tongue, the blocking of the lingual nerve on one side will be sufficient, while if it should involve both sides of the tongue, or the tip, or if the exact extent of tissue involved is unknown, it is always advisable to make a bilateral block. The lingual nerve does not supply all of the structures in the floor of the mouth, and inasmuch as this region receives its nerve supply from other nerve branches, they must be blocked separately by terminal anesthesia. The blocking of the tongue and tissues situated in the floor of the mouth is easily accomplished by injecting the lingual nerve and by deep infiltration injections. In case the new growth is malignant, block anesthesia should not be employed, but a general anesthetic used. Should malignancy be present, and the removal of the submaxillary glands be necessary, it may be very difficult to obtain anesthesia of the deeper structures. However, as previously stated, localized pathological growths situated in the floor of the mouth or on the anterior two-thirds of the tongue may be operated upon under block anesthesia. If the pathological area involves the deeper tissues in the floor of the mouth, it is necessary to block the cervical branches by circular infiltration, which is described elsewhere in this text.

Bloodgood's technic and treatment of malignant tumors of the tongue is no doubt superior to other methods. He advises blocking the tissues of the neck for the removal of the submaxillary glands prior to the removal of the tumor in the region of the tongue. For the second operation, the nerve supply of the tongue and floor of the mouth is completely blocked. The advantage of performing two operations is that the large wound which is made in the neck for the purpose of removing the glands is protected from the secretions in the mouth. The first wound is allowed to heal before the second operation. If the removal of the glands and the tumor situated in the region of the tongue is to be accomplished by two operations, block anesthesia may be employed to admirable advantage, but should not be used if both are to be removed at one operation. In case the tumor is located near the median line or on both sides of the median line in the floor of the mouth, undoubtedly metastases may have taken place on both sides of the neck, and if such is the case, a neck dissection must be made on both the right and left sides. If this is true, the anesthetic solution is injected from one sternomastoid muscle to the other, on a line just below the edge of the jaw. (See Fig. 535.) Such anesthesia will enable the operator to remove the upper lymph nodes on both the right and left sides, and after this primary operation and tissue healing is complete, the tumor, which is located in the region of the tongue or floor of the mouth, can be removed. It is preferable in these cases to employ the cautery knife.

The Base of the Tongue.—If the base of the tongue is involved in the operation, additional nerves must be blocked. The base of the tongue is supplied by the superior laryngeal and glosso-pharyngeal branches. The superior laryngeal right and left branches are blocked by injecting the solution into the thyrohyoid membrane. This nerve passes through the thyrohyoid membrane, which is located one-half centimeter inferior to the posterior extremity of the hyoid bone.

Blocking the Superior Laryngeal Nerve.—The technic for blocking the superior laryngeal nerve is to first place the patient on his back. Bring pressure upon the hyoid bone on opposite side from that of the injection, which makes it more prominent on the side of injection. After this has been accomplished, place the index finger on the greater cornu and force inward and downward to a point one centimeter inferior and anterior to the greater cornu. The amount of solution injected is from three to four mils of a one per cent. In most cases anesthesia is secured in from ten to fifteen minutes, and if the technic has been correctly followed, anesthesia will be sufficient for operations which involve the vocal cords.

Blocking the Glosso-pharyngeal Nerve.—The glosso-pharyngeal nerve is blocked by injecting the solution into the mucous and submucous membranes located anterior and inferior to the tonsil, and in addition a deep injection is made to block the glosso-pharyngeal branches in the region of the base of the tongue on each side. The index finger is placed in the floor of the mouth, which greatly assists in determining the direction of the needle. The needle employed is 60 mm. in length and is guided into the root of the tongue on each side where three mils of solution are slowly injected.

CHAPTER XXXI

BLOCK ANESTHESIA FOR OPERATIONS UPON THE SCALP, FOREHEAD, CRANIUM, AND FRONTAL SINUSES

The scalp is especially favorable for operations under local anesthesia because the nerves supplying these structures have a constant location and are easily accessible. The scalp and its underlying fascia, as well as the periosteum covering the bone, receive their entire sensory nerve supply from branches from below, and as this is the case, it is not difficult to block various areas for scalp operations. The nerves supplying the scalp run for a considerable distance beneath the skin, and after traversing the skin parallel to the surface for a considerable distance penetrate the deep fascia, and small branches enter the bones of the skull to supply the bone and the periosteum. The reader is referred to Figs. 56 and 121 which will illustrate the direction of the various nerve branches supplying the scalp. It will be noticed that the point of exit of the various nerve branches to the scalp can be easily reached by the needle, so that a circumscribed area can be blocked. In most cases the solution is injected at right angles to the direction of the nerve branch, unless the operator is an expert in anatomy and knows exactly where to insert the needle in order to inject the solution near the nerve branch itself. The method of blocking the scalp depends upon the nature of the operation. If it is an ordinary scalp wound, it can be anesthetized by employing the circular or regional method as described on pages 673 and 674. In addition to ordinary scalp wounds, such pathologic conditions as sebaceous cysts, angioma, papillomas, wens, dermoids, endotheliomas, and other growths can be removed by blocking a circumscribed area by the circular or regional method. If the operation is to be an extensive one upon the scalp and other tissues of the cranium, it is much better to block the nerves and their branches as they enter the cranial field by the deep block method. The operator must remember that certain areas of the scalp are supplied by the overlapping of two or more nerve branches, and the blocking of the main branch may not render the part insensitive to pain without anesthetizing other overlapping branches. Therefore, it is necessary to anesthetize all branches entering the operative area, and this is done in one of two ways. First, by the nerve blocking, that is, blocking the nerve as it enters the cranial field: second, by the circular or regional method. In most cases it is far better to block the different nerve branches before they enter the area of operation than it is to block them by the circular or regional method. The operator who is just taking up this form of anesthesia and is not well versed in neural anatomy, will find the circular or regional method much easier, and far better results will be obtained than the blocking of the individual nerve branches before they enter the operative area. In other words, the circular method anesthetizes only the terminal branches just before they enter the operative field, and there is less liability of failure. The experienced operator can distinguish between the pain caused by the terminal branches and that from inadequate blocking of the large branches.

PREPARATION OF THE FIELD FOR OPERATION AND SURGICAL TECHNIC FOR SCALP WOUNDS

Scalp wounds bleed profusely because this field is very vascular, and the first step should be to arrest the hemorrhage. A flap of scalp with only a small pedicle may not slough if the blood supply is not arrested; therefore, when employing local anesthesia the infiltrating of the pedicle with a solution which contains a large percentage of suprarenin should be avoided, as it will interfere with the blood supply for a considerable length of time. The solution should be injected quite a distance from the flap to eliminate possible difficulties. The preparation of the scalp should always be carefully carried out, which is accomplished by, first, shaving the part; always shave it away from the wound, cleaning the tissue with benzin, then dry the surface and apply tincture of iodin. If soap and water are used, the operator should be very careful to see that all traces of soap are completely removed before applying the iodin, as soap and iodin are incompatible.

The next step is to tie off the arteries which may have been severed, in order to arrest the hemorrhage. If the bleeding vessels are small, usually compression is sufficient.

The rules for wound healing which are somewhat out of place here, may be briefly stated, as follows: *First,* complete asepsis; *second,* absolute hemostasis; *third,* accurate coaptation of the edges of the wound; *fourth,* physiologic rest, that is, immobilization of the parts.

Technic of Injection.—If the circular or regional method is employed, the solution is injected around the operative field by first inserting the needle beneath the skin surface, and injecting the solution slowly until a wheal has been produced. The needle is now withdrawn and inserted a second time within the margin of anesthesia which is indicated by the first wheal. The reader is referred to page 673 for the technic of regional or circular anesthesia.

LOCAL ANESTHESIA FOR OPERATIONS UPON THE CRANIUM, DURA MATER AND BRAIN

It is not difficult to produce anesthesia of the entire scalp by blocking the occipital nerve posteriorly, the supraorbital nerves anteriorly, and supratrochlear, and the temporal nerves laterally. The temporal nerves are blocked by injecting just above the zygoma and distributing the solution from the external angular process of the frontal bone to the ear. The needle should penetrate the skin and pass beneath the temporal fascia. The supraorbital and supratrochlear nerves are blocked as they pass over the supraorbital ridge. (See Figs. 526, 527, and 528.) The occipital nerves are blocked as they pass from the deeper tissues. (See Figs. 523 and 524.) If the above nerves are blocked on one side only, anesthesia will be secured to a point near the sagittal suture, where the nerves of the same name from the opposite side overlap the nerves which have been injected. This method is of great value if the operation extends over a considerable area. As will be seen, the scalp on one side is anesthetized. If the operation is of a minor character, or, in other words, if it does not involve an extended area, the terminal method of anesthesia produces gratifying results in most cases. Either the terminal or nerve blocking methods, if carried out properly, will suffice for operations upon the soft parts as well as the trephining of thė skull, such as those involving the dura mater and brain. If deep nerve blocking is not employed, the operative field must be completely surrounded with the local anesthetic solution by the circular infiltration method to insure anesthesia. After the injections have been made encircling the area of operation, the needle should pass through the scalp and should strike the skull; then the needle is held parallel to the outer surface of the bone, and one-half mil of solution is injected. The needle is now advanced beneath the periosteum and one-half mil is injected. For trephining the solution should be injected in the scalp and beneath the periosteum covering the bones of the skull in the region of operation. The operator should mark out the direction of the needle so that no area will be missed in injecting. If the operation is for the trephining of bone and exposure of the brain for a brain operation, the area should be prepared as given on page 737 for operations upon the scalp.

The employment of local anesthesia for operations requiring the entering of the skull and exposure of the brain is a matter of personal equation with the operator. No set rule can be followed to employ or not to employ local anesthesia in certain cases. We know it would be impossible to use local anesthesia in a certain class of patients, such as the highly nervous or neurotic individual, for if the operation is of such extent as to require extensive malleting and chiseling, the psychic effect might do more harm than a general anesthetic. On the other hand, if the patient's physical condition is normal and his mental condition will permit it, or, in other words, if you can obtain his confidence and think you can maintain it throughout the operation, local anesthesia can be used for many injuries of the bone; it makes no difference whether it requires the employment of the trephine, drill, or chisel.

Many times it is essential to use local anesthesia for operations upon the cranium which may have been the result of some severe accident. In such cases the cranium may not only be involved but the throat, jaw, mouth, pharynx, or some other important division of anatomy, and in such instances it will be found that local anesthesia is highly important from the fact that it may guard against the great danger of pneumonia which may follow a general anesthetic.

If the injections are made properly, in most cases the dura mater is completely blocked. It has been proved by many observers on conscious, living subjects that the surface of the brain is insensitive.

In summing up the value of nerve blocking and circular terminal anesthesia for trephining and brain operations, it can be said that with a large number of these operations local anesthesia can be used with satisfaction to both operator and patient, and the outcome of the case be highly gratifying.

The opening of the skull, when the patient is conscious, will probably never become a very popular procedure, for not many patients will submit to the operation and allow their skulls to be opened and chiseled when they are perfectly conscious. However, their physical condition may contraindicate general anesthesia, and local anesthesia might prove to be the method of safety.

BLOCKING THE LARGE NERVE BRANCHES WHICH SUPPLY THE SCALP AND FOREHEAD

The operator must remember that several different nerve branches supply the scalp, and that a number of nerves overlap its borders. These must be blocked if the operation is to be an extensive one. Because of the free overlapping of the various nerve branches, it becomes necessary to block all the overlapping branches which supply the operative area. The operator must always bear in mind that a few terminal nerve branches enter the border of the scalp and supply the part, in addition to the regular main nerve trunks.

The blocking of the several nerves which supply the scalp will now be discussed.

BLOCKING THE SMALL OCCIPITAL NERVE

Topography of Anatomy.—This nerve varies somewhat in size. The author has two wet anatomic specimens showing this branch fully exposed, in one of which it is fully twice as large as in the other. Cunningham states that the nerve may be double. The nerve arises from the cervical plexus, having its origin from the second and third cervical nerves, in most cases beneath the sternocleidomastoid muscle. (See Figs. 43, 60, 121.) It extends posteriorly and superiorly for a short distance along the posterior border of this muscle, then passing to the superficial surface, it enters the deep fascia and into the posterior triangle of the neck where it divides into the auricular, occipital and mastoid branches, also giving off many cervical branches to the neck. (See Figs. 56 and 121.) The occipital and mastoid branches give sensory nerve supply to the scalp, while the auricular branch supplies the skin of the auricle on the cranial surface. The nerve, as it courses upward and backward, is under cover of the posterior border of the sternocleidomastoid muscle, and enters the scalp just posterior to the border of the mastoid process. This nerve branch anastomoses freely with the great auricular and great occipital nerves.

Technic of Injection. The nerve is easily blocked by injecting the solution along the posterior border of the sternocleidomastoid muscle. The needles employed are No. 7 and No. 4. After making the preliminary injection in the skin, needle No. 4, 25 gauge, and 30 millimeters in length, is inserted into the anesthetized skin directly over the posterior border of the muscle and on a line drawn posterior from the angle of the jaw. Or, it can be blocked by inserting the needle directly behind the posterior border of the mastoid process of the temporal bone. (See Figs. 56 and 523. The amount of solution required is two mils.

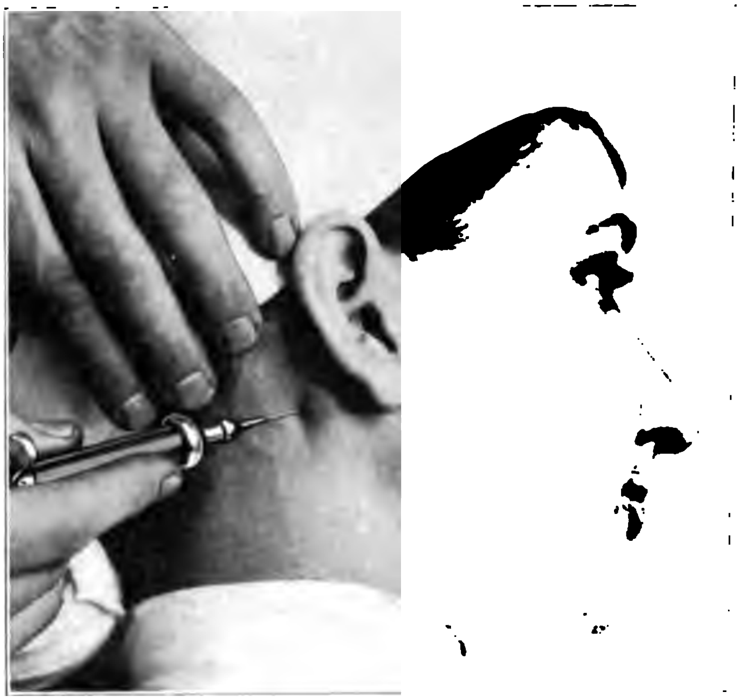


Fig. [illegible]. Location for blocking the lesser occipital nerve.

BLOCKING THE GREAT OCCIPITAL NERVE

Topography of Anatomy. This nerve is the medial branch from the posterior division of the second cervical nerve. (See Figs. 13 and 121.) It pierces the upper part of the trapezius muscle, also the deep fascia of the back of the neck. It enters the scalp on its posterior surface, covering the posterior aspect of the parietal bone and the occipital bone. This is the largest cutaneous nerve supplying the posterior part of the scalp. After the nerve passes through the triangular space, which is bounded by the rectus capitus posticus major, the inferior and superior oblique muscles, it pierces the former muscle, and ascends under cover of the trapezius muscle at a point midway between the mastoid process and the external occipital protuberance. (See Fig. 56.) When it reaches a point near the superior curved line of the occipital bone, it enters the trapezius muscle passing exteriorly to it, and divides into numerous branches which supply the scalp in the occipital region.

This region is not only supplied by the great occipital nerve, but also by small branches from the small occipital nerve from the first cervical nerve.

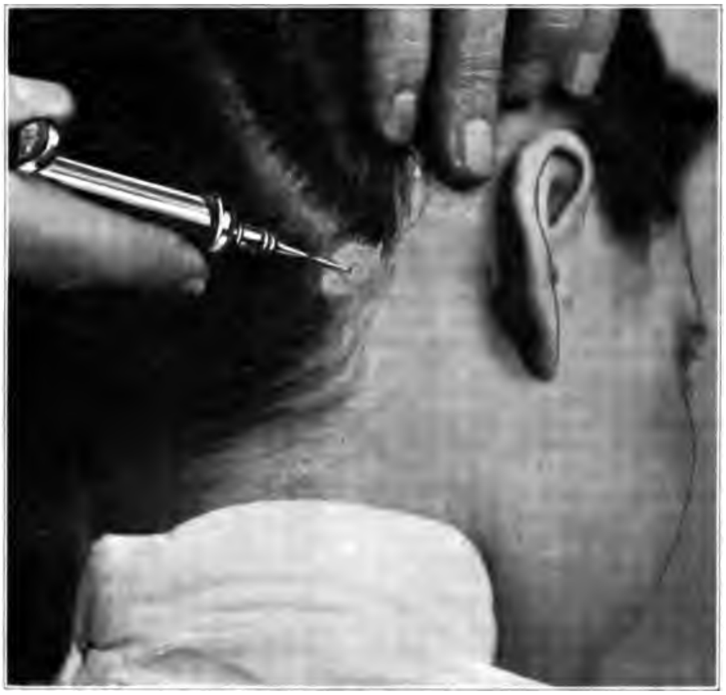


Fig. 524.—Location for blocking the greater occipital nerve.

Technic of Injection.—The great occipital nerve is blocked on a line just beneath the inferior margin of the superior curved line of the occipital bone at a point three centimeters lateral to the external occipital protuberance. (See Figs. 56 and 524.) The amount of solution used for this injection is three mils, and the needles employed are Nos. 4 and 7. The operator must remember that other terminal branches enter the area which is being blocked, and that the blocking of the great occipital nerve may not be sufficient to operate without inflicting pain on the patient, and if the operator finds that sensation remains, a transverse line of anesthesia must be produced along the lower border of the superior curved line.

BLOCKING THE AURICULO-TEMPORAL NERVE

Topography of Anatomy.—This large nerve arises by two roots from the third or mandibular division of the fifth cranial nerve. (See Figs. 40, 48, and 96.) (See Chapter VII for description.) Both roots are sensory and communicate with the otic ganglion which connects it with the glosso-pharyngeal nerve. After this nerve is given off from the posterior division of the mandibular nerve, its course is posteriorly and outward and is situated under cover of the external pterygoid muscle. It passes between the condyle of the inferior maxillary bone and the sphenomandibular ligament, passing through the parotid gland over the root of the zygoma, and courses superiorly to the temple, accompanied by the superficial temporal artery. (See Figs. 95 and 96.) It divides into several branches, but the two largest are the auricular and temporal which supply the lateral surface of the head, that is, the temple and scalp with sensation. The terminal branches of this nerve reach a point near the vertex of the skull.

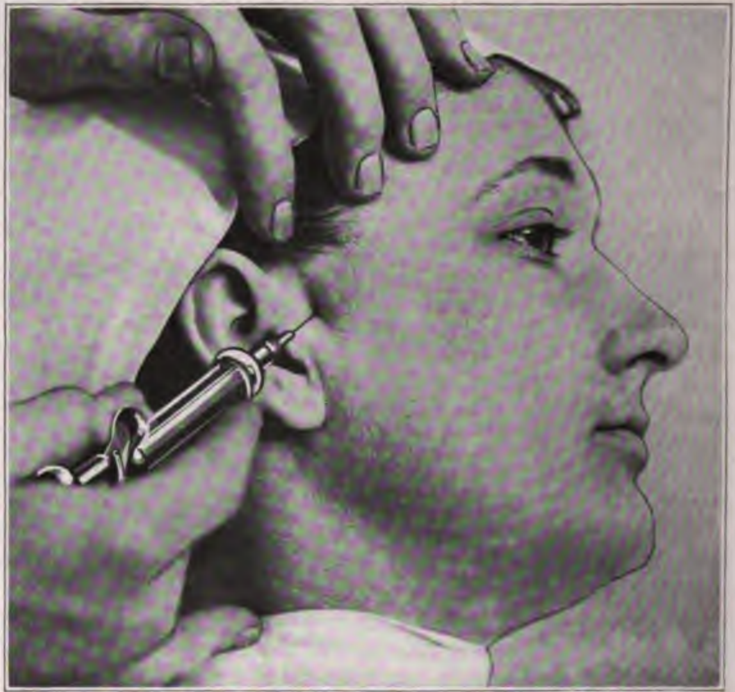


Fig. 525.—Location for blocking the auriculotemporal nerve.

Technic of Injection.—The auriculo-temporal nerve is blocked by injecting the solution under the skin at the upper surface of the zygoma at a point one-half centimeter posterior to the temporal artery. The needle should penetrate the skin and subcutaneous tissue to a depth of one-half to one centimeter. The nerve is located posterior to the root of the zygoma.

Two mils of a 2 per cent solution are injected with needles Nos. 4 and 7. (See Figs. 56, 95, and 525.)

BLOCKING THE FRONTAL NERVE

Topography of Anatomy.—The frontal nerve is a continuation of the first or ophthalmic division of the fifth nerve. It enters the orbit after passing through the superior orbital fissure and is located in the roof of the orbit, being situated above the orbital muscles. (See Figs. 51 and 60.) It courses anteriorly in the roof of the orbit above the levator palpebræ superioris muscle, and in most cases the nerve is in contact with the periosteum covering the roof of the orbital cavity. At a point about midway between the anterior and posterior parts of the orbit it divides into the supratrochlear and supraorbital branches. (See technic below for blocking the supraorbital nerve.)

BLOCKING THE SUPRAORBITAL NERVE

Topography of Anatomy.—This nerve courses anteriorly along the periosteum covering the roof of the orbit until it reaches the supraorbital foramen or notch, where it passes out and then courses upward over the forehead. (See Figs. 35, 56, and 60.) Its branches supply the skin, subcutaneous tissue, muscles, and periosteum in that region. It divides into:

1. The frontal branches which supply the scalp and forehead, and pass as far distally as the vertex. (See Fig. 56.)
2. Branches which supply the upper eyelid.
3. Branches which supply the mucous membrane and bone of frontal sinus.

Technic of Injection.—This nerve may be blocked by using either the inner or outer orbital injections. If these injections are employed, not only will the supraorbital nerve be blocked, but the supratrochlear, because the solution is deposited far enough posteriorly in the roof of the orbit to block the frontal nerve before it divides into the supraorbital and supratrochlear divisions. (See Figs. 40 and 60.) In case the supraorbital nerve is desired to be blocked independently of other branches, the technic is as follows:

Locate the supraorbital notch or foramen with the index finger. It is situated in the supraorbital margin of the frontal bone to the lateral of the medial angular process. It is also located at the junction of the second and third fifths of the supraorbital margin. (See Figs. 32 and 35.) The needles employed for making this injection are Nos. 4 and 7. (See Fig. 177.) After making the preliminary injection of one-half mil with needle No. 7, needle No. 4 is inserted into the skin directly over the supraorbital nerve as it makes its exit through the supraorbital notch or foramen. When the solution is injected, the point of the needle should be in contact with the periosteum in this immediate region. Two mils of the solution will give profound anesthesia in three or four minutes following the injection. (See Fig. 526.)

BLOCKING SUPRATROCHLEAR NERVES

Topography of Anatomy.—This is a branch of the frontal nerve. It is situated to the medial of the supraorbital branch. (See Fig. 56.) It courses forward along the periosteum covering the roof of the orbit, crossing the tendon of the superior oblique muscle, leaving the orbit to the medial of the supraorbital notch or foramen, which gives exit to the supraorbital nerve. (See Figs. 40 and 60.) After it passes out of the orbital cavity, it bends over the periosteum covering the supraorbital margin of the frontal bone, and divides into numerous sensory branches which supply the skin and other structures in the center of the forehead, medial aspect of the eye, and root of the nose.

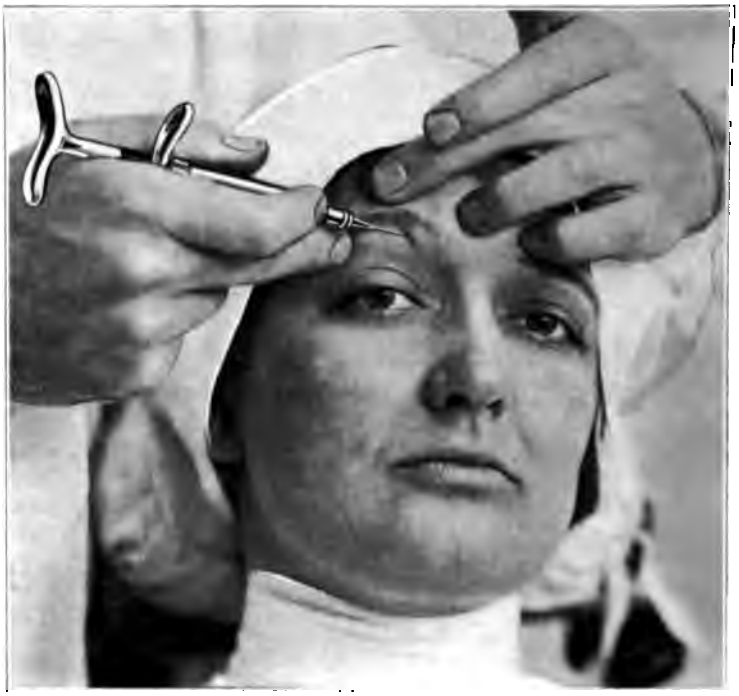


Fig. 526.—Needle in position for blocking the supraorbital nerve.

Technic of Injection.—This nerve is blocked by inserting the needle into the skin directly over the supraorbital margin at a point 1 cm. medial to the supraorbital notch or foramen. The needle is forced into the tissue until it strikes the periosteum which should be at an approximate depth of 7 mm. The amount of solution injected is two mils, and the needles employed are the same as those for blocking the supraorbital nerve.

THE COMBINED BLOCKING OF THE SUPRAORBITAL AND SUPRATROCHLEAR NERVES

This is accomplished by one injection and is desirable if the operation extends over a sufficient area of the forehead and scalp to necessitate the blocking of both divisions. (See Fig. 56.) Instead of making individual injections for each nerve branch, the needle is inserted midway between the two nerves as they pass upward and over the supraorbital margin. Needle No. 7 is employed to make the preliminary injection through the skin and subcutaneous tissue, to be followed by the regular needle which is advanced through the tissues until the point is resting against the periosteum. Four mils of a 2 per cent solution are injected which will produce profound anesthesia in both nerves within three minutes. The average distance between the supraorbital and supratrochlear branches at the point of injection is approximately 1 cm.; therefore, if the solution is injected midway between the two points, it will only have to infiltrate a distance of 5 mm. laterally and medially to block the respective nerve branches. (See Figs. 527 and 528.)

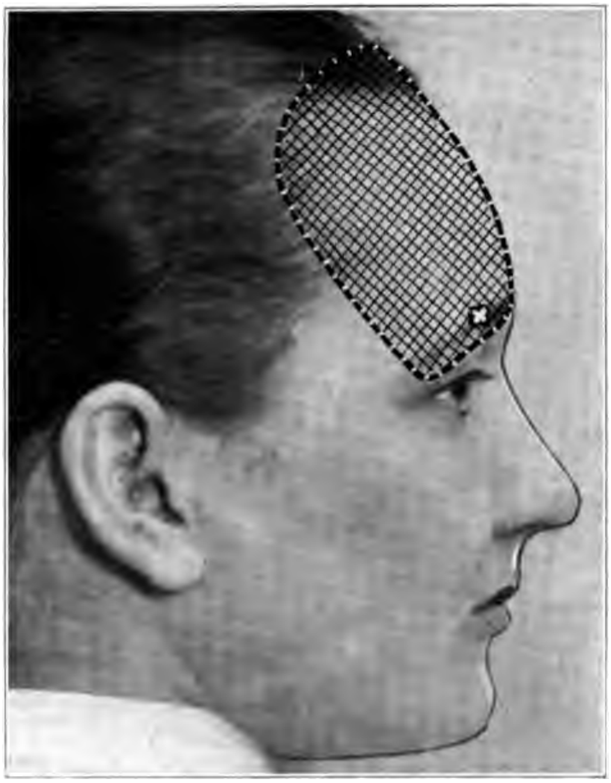


Fig. 527.—Area of anesthesia secured by blocking the supraorbital and supratrochlear nerves on one side. *X* shows point of injection.

BLOCKING THE NERVE SUPPLY TO THE FRONTAL SINUS

The area of the frontal sinuses is anesthetized by combining the nerve blocking and terminal methods. The local method employed a number of years ago for anesthetizing the area of the frontal sinus, was to infiltrate the overlying tissue and periosteum covering the sinuses, which in many cases was a failure. The nerves blocked are the supraorbital, supratrochlear, ethmoid, and the second or maxillary division of the fifth nerve. The blocking of the latter named nerve anesthetizes the small nerve branches which supply the structures situated between the frontal sinus and nasal cavity. It was Peuckert who first presented the technic for blocking the nerve supply to this region and it was later improved by Braun.

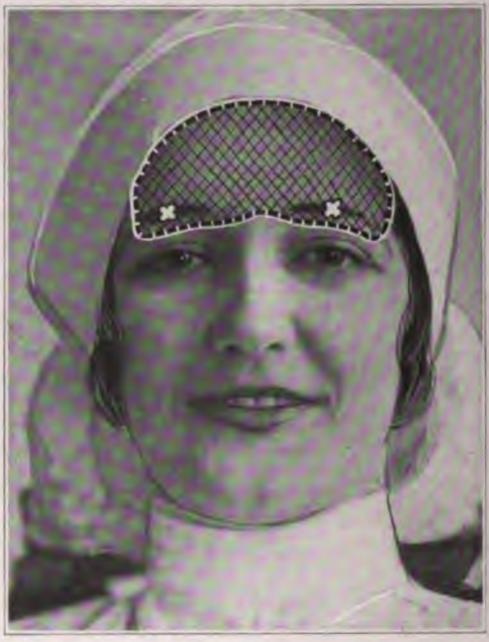


Fig. 528.—Illustrating the area of anesthesia produced by blocking the right and left supraorbital and supratrochlear nerves. X shows point of injection.

Technic of Blocking.—First block the second division of the fifth nerve by the intraoral method. (See page 380 for technic.) Then make a medial orbital injection to block the anterior and posterior ethmoidal nerves which supply the mucous membrane of the sphenoid and frontal sinuses, together with the mucous membrane covering the cribriform plate of the ethmoid bone, as well as other nearby structures. (See page 375 for technic.) In addition to supplying the above named tissues, the anterior ethmoidal nerve also supplies the upper portion of the mucous membrane lining the nasal cavity, after which its branches pass downward and forward and are distributed to the skin covering the tip of the nose. It makes its exit between the cartilaginous or bony parts which assist in the formation of the nose. (Fig. 56 illustrates the nerves passing through the skin.) The blocking of the anterior and posterior ethmoidal nerves by the medial orbital injection is to puncture the skin at a point 2 cm. above and lateral to the inner canthus of the eye just beneath the supraorbital margin. (See number 1, Fig. 529.) The needle is advanced posteriorly and in contact with the periosteum to a depth of 4 cm. (For technic of medial orbital injection see page 375.) Inject 5 mils of a 2 per cent procain suprarenin Ringer solution.

The walls of the orbit, which are practically straight, are especially adapted for blocking the branches of the ophthalmic division. The operator should exercise every care in observing that the bevel of the needle is advanced in actual contact with the periosteum. The outer and medial walls of the orbit have surfaces that make them ideal for inserting a needle in that particular location. The operator should never insert the needle in any location in the orbit where it is not possible to keep the needle in contact with the periosteum. If the lateral wall of the frontal sinus is to be removed, it may be necessary to make a lateral orbital injection, but in most cases it is not necessary. (See page 372 for technic.) In addition to blocking the second division of the fifth nerve (see page 380 for technic) and the blocking of the anterior and posterior ethmoidal nerves by the inner or medial orbital injection, other injections are necessary for blocking the other sensory

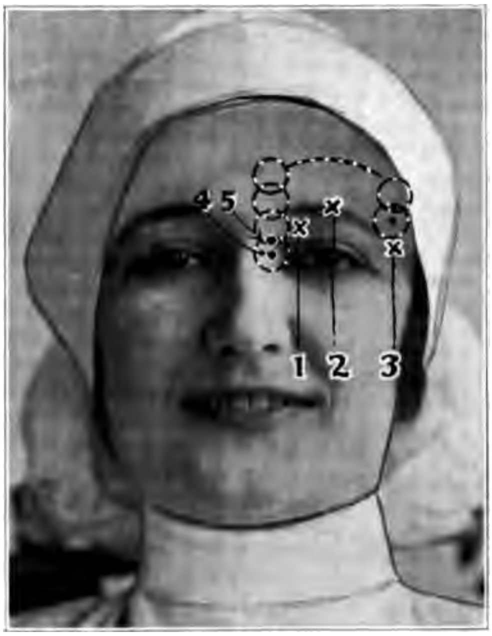


Fig. 529. Illustrating points of injections for frontal sinus operation. 1, Medial orbital injection; 2, location for blocking supraorbital and supratrochlear nerves; 3, point for blocking lacrimal nerve; 4 and 5 represent terminal circular method. Note how the injections are extended horizontally near median line, then laterally and downward to external canthus of the eye.

branches. The next step is to block the sensory nerves, which are the supratrochlear, supraorbital and lacrimal over the supraorbital margin. Numbers 2 and 3 in Fig. 529 represent points of injection for blocking supraorbital, supratrochlear and lacrimal nerves. Inject 2 mils of a 2 per cent solution for each injection. Following the above, inject a 1 per cent solution by the circular method by inserting the needle in the skin lateral to the bridge of the nose. First inject one and a half mils for the preliminary injection to the side of the bridge of the nose, which will produce a distinct wheal. (See No. 4 in Fig. 529.) Remove the needle and repeat injection within the margin of the anesthetized zone, as indicated by number 5, Fig. 529. Repeat this technic, injecting one and a half mils of a one per cent solution as often as necessary to cover the area extending from the bridge of nose, upward, laterally and downward to external canthus of eye as shown in Fig. 529. The total amount of solution for all the injections is as follows:

Eight mils of a 2 per cent solution for the two deep injections, that is, the blocking of the second division of the fifth nerve, and the blocking of the anterior and posterior ethmoidal branches of the ophthalmic division by the medial orbital method. Approximately seventeen mils of a 1 per cent solution are injected for blocking the various other branches as enumerated above. If these injections have been accurately made, perfect anesthesia will be secured in the skin, periosteum, mucous membrane, bone and other structures in the region of the frontal sinus, and an operation involving the frontal sinus can be performed absolutely without pain. All soft tissue and bone tissue supplied by the nerves anesthetized can be operated upon with success; even a portion of the ethmoidal cells can be successfully removed.

The profound anesthesia and the anemia, which causes an almost bloodless field of operation, makes the eye, ear, nose and throat specialist enthusiastic over the method, when it has been demonstrated to him just what can be accomplished through this medium.

The reader should familiarize himself with the osteology of the walls of the orbit, and nerve supply before attempting the blocking for a frontal sinus operation.

CHAPTER XXXII

BLOCK ANESTHESIA FOR ALVEOLECTOMY; FRACTURE AND EXCISION OF LOWER JAW; SKIN GRAFTING; REMOVAL OF TUMORS; REMOVAL OF FOREIGN BODIES; PARACENTESIS; MASTOID; REMOVAL OF CERVICAL LYMPH GLANDS AND THYROIDECTOMY

BLOCK ANESTHESIA FOR ALVEOLECTOMY

In most cases alveolectomy is performed immediately following the extraction of the teeth and no additional anesthesia is required other than that produced for the extraction of the teeth.

However, if an alveolectomy is to be performed on a patient who has had his teeth extracted previously, the blocking of the second or superior maxillary division of the fifth cranial nerve on the right and left sides by the intraoral method is sufficient for the operation in the upper jaw. If the process is to be removed in a circumscribed area, the deep block injections which are necessary, depend upon the location of the operation and do not differ from the technic which has been given for the blocking of the teeth in the different zones; therefore, the reader is referred to various parts of the text for this information. If the operation is upon the lower jaw it will be necessary to block the long buccal nerve in 75 per cent of cases, otherwise the blocking of the right and left inferior dental-lingual nerves will suffice.

BLOCK ANESTHESIA FOR REDUCTION OF FRACTURE OF LOWER JAW

If the fracture is a simple one located in the body of the mandible at some point between the lower third molar and the cuspid fossa, usually the inferior dento-lingual blocking is sufficient. However, if it is a compound fracture involving considerable tissue, it is then necessary, in addition to the inferior dento-lingual, to block the branches from the cervical plexus by the terminal infiltration method. This is accomplished by injecting the solution along the lower border of the mandible. If infection is present, then instead of making the inferior dento-lingual injection by the intraoral method, the third or mandibular division is blocked at the foramen ovale by the extraoral method. (For technic, see page 396.) If the third or mandibular division is blocked, in most cases it is necessary to anesthetize the communicating or overlapping branches from the cervical plexus by infiltrating the skin and deep tissues along the lower border of the mandible as illustrated in Fig. 408. The skin and deeper tissues are injected from a point posterior to the angle of the jaw and as far anteriorly as is necessary, this depending upon the location of the fracture.

If the fracture is located in the region of the mental foramen, then infiltrate to a point near the incisive fossa. If the fracture is in the region of the lower cuspid tooth, infiltration is extended to the median line. If the fracture is situated in the incisive fossa, or at the symphysis, then the line of infiltration should extend to the region of the cuspid tooth on the opposite side. If the fracture is located in the region of the mental foramen, cuspid tooth, incisive fossa, or median line, it will be necessary to block the overlapping lingual branches from the opposite side by injecting the solution into the mucous membrane in the floor of the mouth, and gum tissue covering the lingual alveolar plate as described on pages 619 and 629 and Figs. 454 to 468. In addition to the above injections it will be necessary to make several injections along the lingual alveolar plate by extending the needle through the skin into the deep tissues and in contact with the periosteum from beneath the skin. This process is repeated as often as necessary to anesthetize the tissues which are involved.

BLOCK ANESTHESIA FOR EXCISION OF THE LOWER JAW

It is very fortunate indeed that this operation is not a common one. However, it is necessary that the jaw be removed in extreme cases of carcinoma or sarcoma of the alveolar region. Block anesthesia may be used in the removal of either a section, or excision of the lower jaw. The technic is as follows:

The cervical plexus is blocked by injecting the solution along the sternocleidomastoid muscle as illustrated in Figs. 536, 537 and 538. The injection should be made extending from the anterior surface of the mastoid process to the clavicle. In addition the solution is injected by the terminal infiltration method from a point midway between the mastoid process and clavicle, anteriorly to the tip of the chin and upward in the median line, until the region of the lower lip is reached. In addition to the above injections, the mandibular or third division of the fifth nerve is blocked at the foramen ovale by the extraoral method. (For technic, see page 525.) It is also necessary to block the mucous membrane and subcutaneous tissues in the floor of the mouth. (See technic, page 749, for "Reduction of Fracture of Lower Jaw.") If the jaw is to be excised at the median line no other injections are necessary. However, if the jaw is to be incised posterior to the median line, it then becomes necessary to block the overlapping branches on the opposite side.

BLOCK ANESTHESIA FOR SKIN GRAFTING

Block anesthesia can be used to great advantage for anesthetizing the area from which the skin graft is to be removed. Usually the skin is removed from the leg and the terminal infiltration method is employed. If the skin is to be transplanted, such as following the removal of a tumor, it should be done at the same time the tumor is removed. However, if the skin is to be transplanted to an area which has been operated upon previously, and one which is covered with granulation tissue, the raw open wound can be anesthetized by applying compresses which are saturated with a 20 per cent procain suprarenin Ringer solution. (See formula, page 694.) After leaving the compress in position for fifteen minutes the granulation tissue and surface are freshened by scraping before the skin grafts are applied. The part where the skin is to be removed is anesthetized by the terminal infiltration method, the skin being infiltrated in a circular manner in the shape of a horseshoe, the open end located toward the distal end of the leg, if the skin is being removed from the leg.

Profound anesthesia will be secured by thoroughly infiltrating the skin by the subcutaneous method and by injecting a quantity of the solution subdermically. If the solution is injected subdermically, considerable time should elapse to produce complete anesthesia. The solution should be injected both subcutaneously and endermically to secure the best results. If the solution is injected only subcutaneously, a profound anesthesia of the skin may not be obtained because the solution may not thoroughly permeate the skin.

BLOCK ANESTHESIA FOR THE REMOVAL OF TUMORS

Either the deep block or the circular terminal method, or both, may be employed in the removal of tumors, especially those of the benign type. Many superficial tumors can be thoroughly anesthetized by the terminal infiltration method with little or no difficulty. It is self-evident that the operator's qualifications for the surgical removal of tumors, particularly the benign type, under block anesthesia, are an accurate estimate of his knowledge and skill with both block anesthesia and surgery. If the tumor is large and either benign or malignant, only the operator can be the judge as to the advisability of undertaking the operation under block anesthesia.

SMALL CIRCUMSCRIBED BENIGN TUMORS

Small benign tumors located subcutaneously, such as lipomas and other similar forms, can be removed by the circular or infiltration method. The solution is injected around the tumor, and in addition the base of the tumor is blocked as shown in Fig. 473. The technic for this method of local anesthesia has been fully described on page 673.

BLOCK ANESTHESIA FOR REMOVAL OF SMALL LOCALIZED TUMORS

Before the operator attempts to block the area for tumors which are localized in the skin and subcutaneous tissue, such as papillomas, cysts, nevi, and similar new growths, he should be positive that the tumor is small and confined to a circumscribed area. If this is the case, the circular infiltration method, described on page 673, may be employed for the excision of the new growth. Should the circular infiltration method be inadequate, then the deep block method should be employed. The operator must be cautious in the removal of malignant tumors, as remnants left will cause a recurrence of the growth at a later date. If necessary, the opening left in the skin and subcutaneous tissue by the excision of these tumors can be readily closed by skin grafting.

BLOCK ANESTHESIA FOR REMOVAL OF MALIGNANT TUMORS

The removal of a malignant tumor, particularly one which has undergone regional metastasis, is a subject which should be given careful preoperative and diagnostic consideration. If the tumor involves considerable tissue, a general anesthetic is indicated. A small tumor is easily removed, provided the deep block injections have been correctly made. The removal of the surrounding lymph glands must also be considered. The removal of a malignant tumor, especially one which has undergone regional metastasis, without the removal of the local lymph glands, is a curse to modern surgery, as such a procedure is only inviting a recurrence of the malignant growth.

It makes no difference whether a malignant tumor is removed under general or block anesthesia, as far as the removal of the tumor and surrounding lymph glands is concerned; just because the area of operation is blocked under local anesthesia and the tumor itself excised, does not excuse the operator from the obligation he owes his patient for the complete removal of the regional lymph glands. Most of these operations are of a two-step type, that is, the lymph glands should be removed first, and after the incision has healed, then the tumor itself is removed.

Take, for example, an epithelioma of the lower lip, the primary operation should consist of a removal of the glands of the neck, and after the incision has healed a second operation for the removal of the epithelioma itself. If the operation is conducted in this manner, there is less probability that the epithelioma will return or the cervical lymph glands will be involved later. (For technic, see page 756 for the blocking of the cervical plexus and surrounding tissues which is sufficient for the removal of the lymph glands.) The injections for the removal of a malignant tumor depend upon its location and the amount of tissue involved.

BLOCK ANESTHESIA FOR LOCATING FOREIGN BODIES

Block anesthesia is of great advantage for locating fragments, such as sewing needles, hypodermic needles, or other foreign bodies in the skin or other tissues of the body. Many operators have not been able to find the broken fragment under local anesthesia because they have not made an incision of sufficient size to probe for it; failure in many cases has been due to not thoroughly anesthetizing the tissue. It is always well to take an x-ray picture of the part to locate the position of the fragment before blocking; this will greatly aid the operator in knowing how large an area to block and how long or deep an incision to make. After locating the needle by the use of the x-ray, it is good practice to make a transverse incision, as in this manner the lancet will strike the broken fragment. (See Figs. 567 and 568.)

LOCAL ANESTHESIA FOR PARACENTESIS

The incising of the tympanic membrane inflicts excruciating pain unless the part is thoroughly anesthetized. A solution which has given considerable satisfaction is as follows:

℞	Phenol (95 per cent)	mil 1
	Procain crystals	grams 4
	Menthol	grams 2
	Alcohol	mils 3
	Misce.	

A small tampon of cotton is saturated with the above solution and placed in contact with the tympanic membrane where it is allowed to remain for five minutes, then it should be removed and the technic repeated. For paracentesis no injection is made.

BLOCK ANESTHESIA FOR MASTOID OPERATIONS

Block anesthesia for mastoid operations can be utilized in a most gratifying manner.

The injections which are made for a radical mastoid operation are as follows:

1. Circular infiltration anesthesia is employed by injecting the solution in a circular manner around the ear as illustrated in Fig. 530. After anesthetizing the skin and subcutaneous tissue around the ear, the needle is passed into the deeper tissues as indicated by the arrows in Fig. 530. Each one of the circles represents an area which has been injected with at least one mil of a one per cent procain suprarenin Ringer solution. When the needle is passed into the deep tissues laterally, as indicated by the arrows, 1 to 1½ mils of the solution should be slowly injected into the deeper parts. Braun states that it is unnecessary to inject the solution beneath the periosteum because the periosteum, bone, and cells receive their nerve supply from nerves passing from the soft parts and are therefore blocked by the solution being injected into the soft tissues.

2. A second injection is made to anesthetize the skin of the meatus by inserting needle No. 4, which is 25 gauge and 30 mm. in length, just behind the ear as illustrated in Figs. 531. The needle is advanced inward just anterior to the mastoid process until the point has reached the bony canal. Considerable

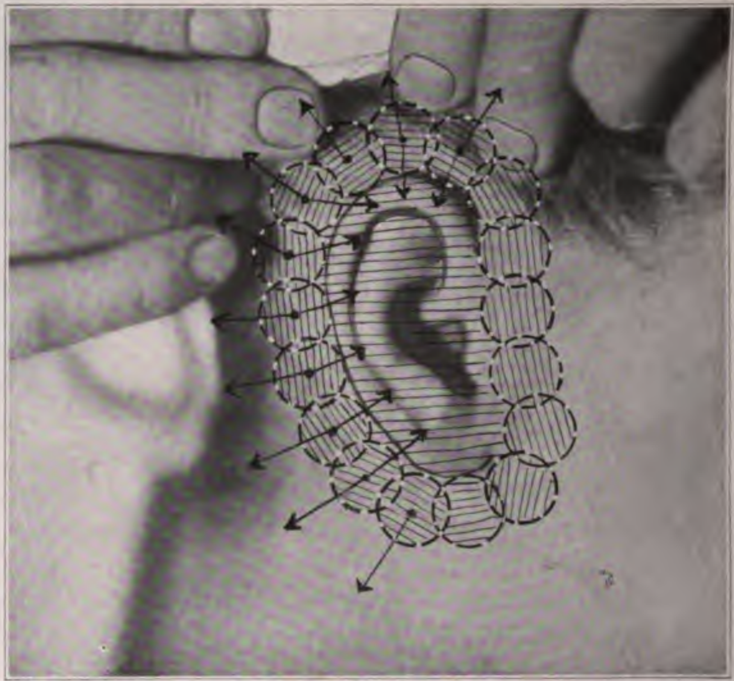


Fig. 530.—Area of first injections for blocking the mastoid region which are made by the circular infiltration method, after which the needle is advanced into the deeper tissues as indicated by arrows.

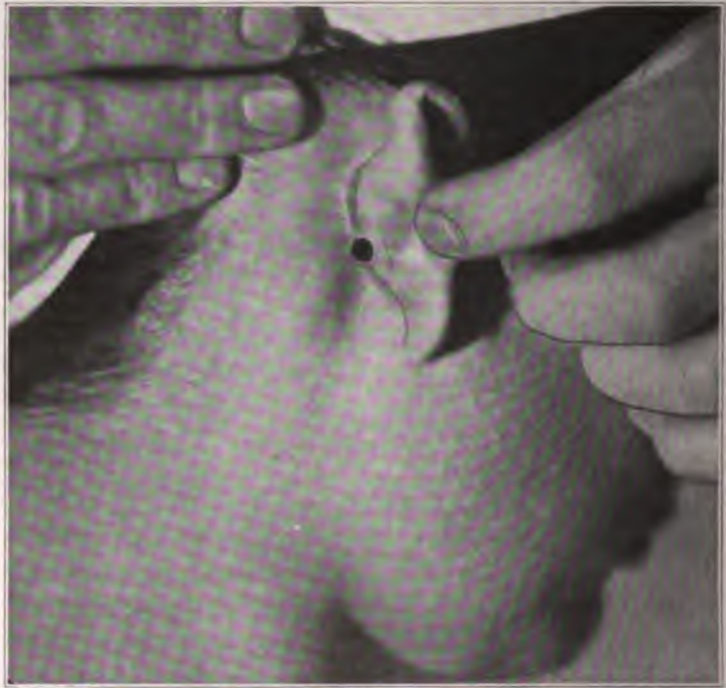


Fig. 531.—Area of second injection which is made at the point indicated by dot for anesthetizing the mastoid region.

care must be exercised not to puncture the meatus while inserting the needle behind the ear between the cartilaginous canal and the skin of the meatus. For this injection at least two mils of a 2 per cent procain suprarenin Ringer solution should be slowly injected.

Newman and Braun recommend that the circuminjection around the ear, as shown in Fig. 530, should be done. At least 20 mils of a 1 per cent procain suprarenin Ringer solution should be injected and the greater part into the tissue below the ear, over and anterior to the mastoid process in the region of the occipital and auricular nerves. The auditory canal should be carefully anesthetized by drawing the ear anteriorly, as shown in Fig. 531, and the needle inserted into the skin at the point indicated, and advanced inward to the bony canal just anterior to the surface of the mastoid process. At least three mils of a 2 per cent procain suprarenin Ringer solution should be deposited at this point. If it is found, after making the above-named injection, that the tympanic tissues are not thoroughly anesthetized, a 20 per cent procain suprarenin Ringer solution should be dropped into the canal.

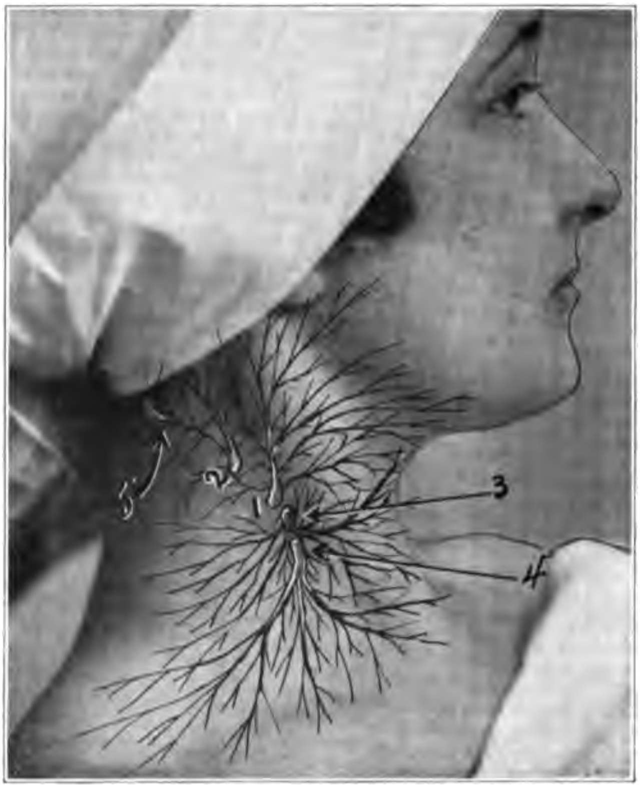


Fig. 532. Branches of the cervical plexus which are blocked for removal of goiter or cervical glands. Solution is injected posterior to sternocleidomastoid muscle. Note the prominence of this muscle.

1, Great auricular; 2, lesser occipital; 3, cutaneous cervical; 4, supraclavicular; 5, greater occipital.

If the injections are carefully made as given, it will be found that anesthesia will be obtained, and very little hemorrhage will ensue during the operation due to the anemia produced from the vaso-constricting action of the suprarenin. Before making the above injections for a radical mastoid operation, the patient is given a preliminary injection of morphin-scopolamin, thirty minutes before the operation. One of the contraindications of block anesthesia for a radical mastoid operation is that the patient in most cases objects to the chisel employed in the operation. This method should never be employed upon patients who are nervous and excitable, or in cases of acute otitis media or in phlegmonous suppurations. Before attempting to use local anesthesia, the operator should be positive that he can control his patient during the operation and not have him in an excitable and nervous state; also that the parts are not greatly inflamed or in a condition which would make it impossible to thoroughly block the nerve supply. Block anesthesia for this operation has its indications and contraindications, just the same as any other surgical operation and when employed by one skilled in making the injections and upon a patient who is not excitable and nervous, gratifying results will be obtained.

REMOVAL OF CERVICAL LYMPHATIC GLANDS; THYROIDECTOMY AND OTHER OPERATIONS INVOLVING THE NERVE SUPPLY OF THE NECK

The writer considers it necessary to include the blocking of the nerve supply of the anterior portion of the neck in this text, because this region is so closely associated with the operations performed by the oral surgeon in the region of the jaws, such as tumors, fractures, etc.

Topography of Anatomy.—The nerve supply of the anterior portion of the neck is from the cervical plexus and third division of the fifth nerve. This plexus is formed from the anterior branches of the first, second, third and fourth cervical nerves and is divided into superficial and deep branches. The beginning of the anterior branches are covered by the sternomastoid muscle. The superficial branches are as follows: Occipitalis minor, which is below and posterior to the mastoid process supplying the scalp and periosteum; great auricular, which divides into the mastoid, auricular and facial branches and supplies the tissues in the region of ear and mastoid; superficialis colli, which supplies the tissues situated in the anterior portion of the neck; supraclavicular, suprasternal and supracromial branches which supply the lower portion of neck. (See Figs. 532, 533 and 534.) All the above-named branches supply the structures situated in the anterior and lateral portions of the neck. The deep set are as follows: Muscular branches; communicating branches to the pneumogastric, hypoglossal, communicans hypoglossi and phrenic. The only branches in which we are interested in block anesthesia, for operations on the neck, are the superficial branches which emerge from their deep location along the posterior border of the sternomastoid muscle, situated at a point midway between the mastoid process and the sternoclavicular articulation. (See Figs. 532, 533, and 534.)

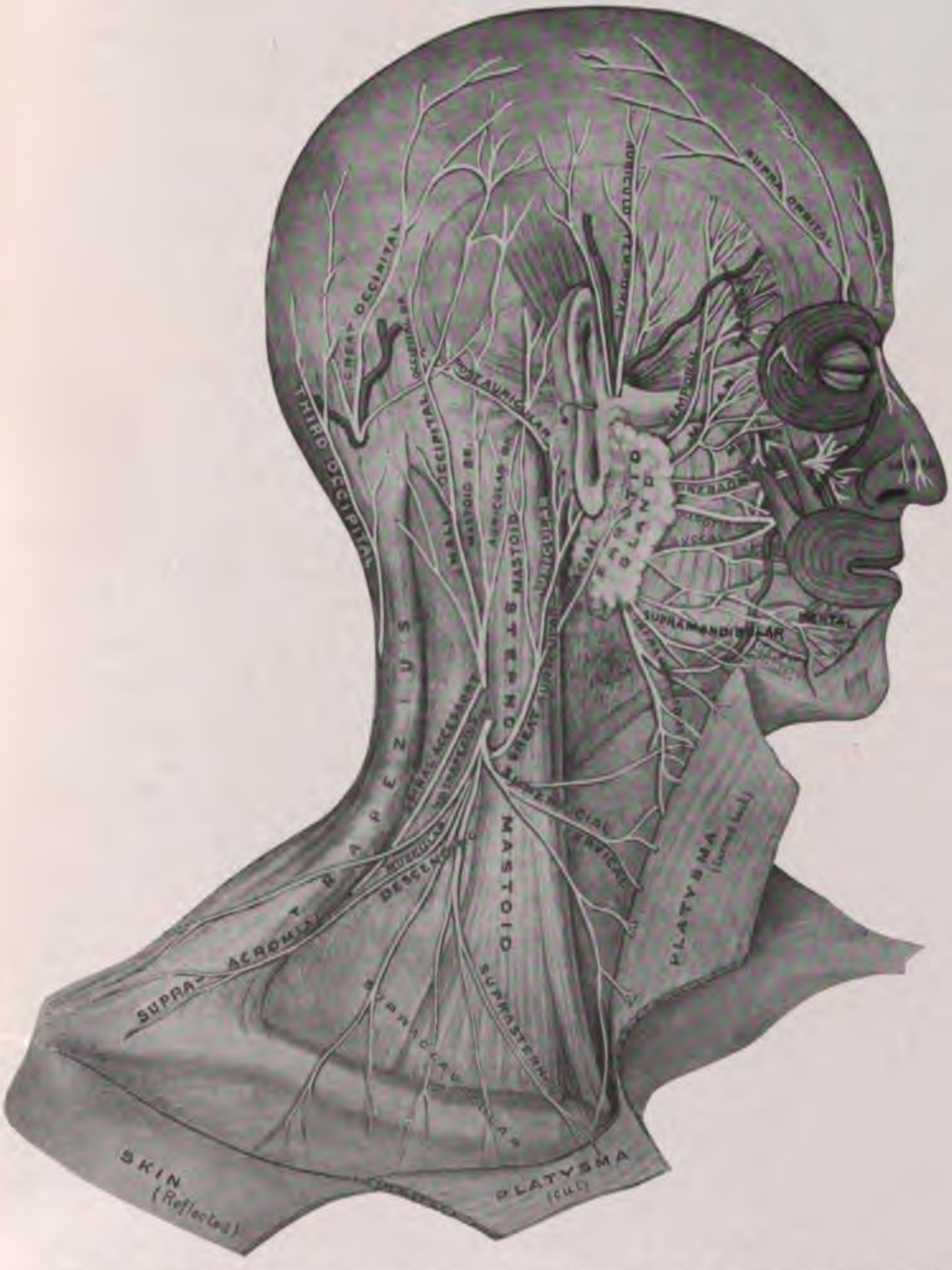


Fig. 533.—The facial nerve, cutaneous branch of the fifth nerve, and superficial cervical nerves. (Retouched from Testut.)

BLOCK ANESTHESIA FOR THYROIDECTOMY

Until recent years general anesthesia has been employed almost exclusively for the removal of goiter, but since the advent of the deep block method surgeons are employing it with gratifying results. The reason for failures from local anesthesia in the past has no doubt been due to the improper injection of the solution. Braun states that there were 157 thyroidectomies performed under local anesthesia in the Zwickau Hospital from 1908 to 1911. Crile employs both block method and nitrous oxid oxygen anesthesia, thereby producing anoci-association. It was Bier who first suggested the possibility of performing surgical operations in the region of the neck under local anesthesia and also strongly advocated it in thyroidectomy. Hertzler is also an advocate of local anesthesia for such operations as the removal of the cervical lymphatic glands, thyroidectomies, etc., and states, "With all details mastered, thyroidectomy under local anesthesia becomes an exceedingly satisfactory and simple operation."

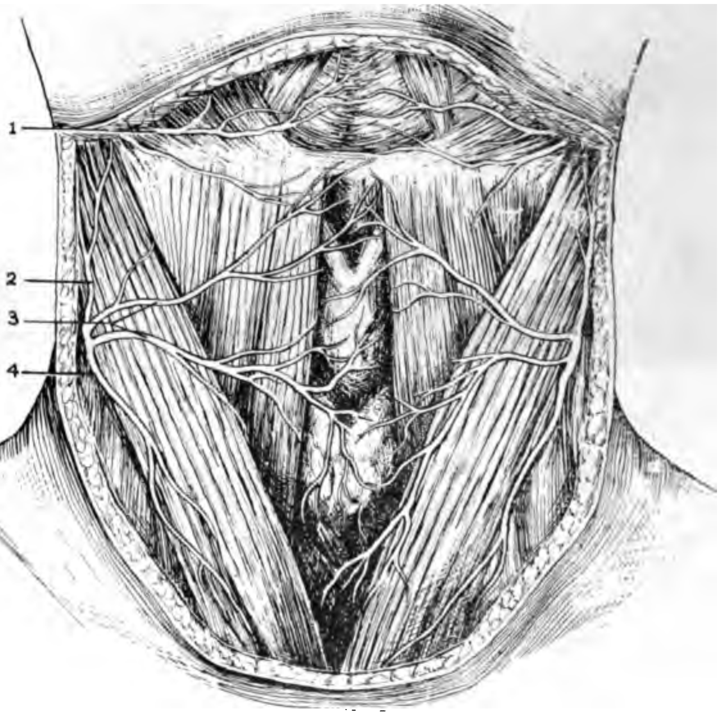


Fig. 534.—1, Cervical branch of facial; 2, great auricular; 3, cutaneous colli; 4, supraclavicular.

The writer will quote Matas from Allen's "Local Anesthesia," as follows:

"In surgery of the region of the neck local anesthesia has made large and permanent conquests. The neck is most favorable for the display of the infiltration method, the perineural and intraneural methods of regional anesthesia having found comparatively few difficult applications. In the neck the lesion of the skin and its appendages and those of the supraaponeurotic planes are everywhere submissive to cocain or its allies. Local infiltration is most valuable in dealing with inflammatory lesions—abscesses, boils, inflamed sebaceous cysts, and carbuncles of moderate size. In opening deep cervical abscesses connected with submaxillary and pharyngotonsillar infections, in which the suppurative focus must be reached by careful dissection, it is most valuable.

In the major surgery of the neck, local infiltration finds its most brilliant application in the anterior cervical and subclavian regions, and in the operations on the vessels in the carotid triangle.

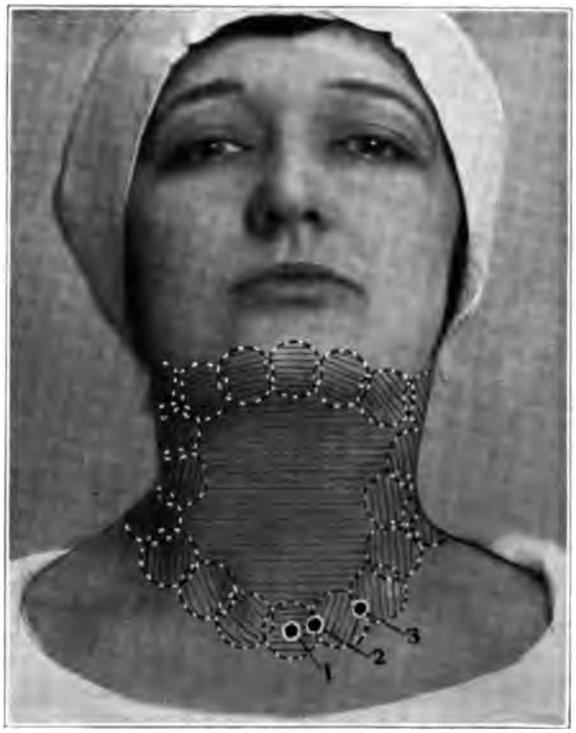


Fig. 535.—Illustrating points of injection and area of anesthesia for removal of cervical lymphatics by the circular infiltration method.
1, Primary injection which is made with a fine sharp needle; 2 and 3, secondary injections.

"Apart from the avoidance of postoperative constitutional disturbances, the immediate advantages of local anesthesia are that it permits the dissection of the part with the precision, neatness, and deliberation that are required in all the deep vascular regions; that the great purgidity of the veins and general increase in vascularity incident to the use of inhalation anesthetics is avoided; and the surgeon is materially assisted in his work by the different attitudes that the patients can assume to favor the better exposure of the parts.

"In the postcervical triangle the conditions for local anesthesia are less favorable, except in the supraclavicular space, in which the subclavian artery and brachial plexus are literally exposed for operative purposes."

"One of the most convincing proofs of the great extension of local anesthesia in the surgery of the neck has been given by Kocher and his followers in the numerous operations for the cure of goiter. When we consider the statistics of operation for goiter, as furnished by the clinics of Kocher, Roux, Reverdin, Socin, Bruns, Mikulicz, Burkhardt, and other surgeons who practice in the great zone of goiter infection in Europe, amounting to thousands of cases, and that since the value of cocain as an anesthetic was first established by Kocher, who alone claims the larger majority of many thousand goiter cases of cocain operations, local anesthesia has become a routine practice in such cases, we will realize what a large slice of surgical territory has been wrested from the domain of general anesthesia in this region alone."

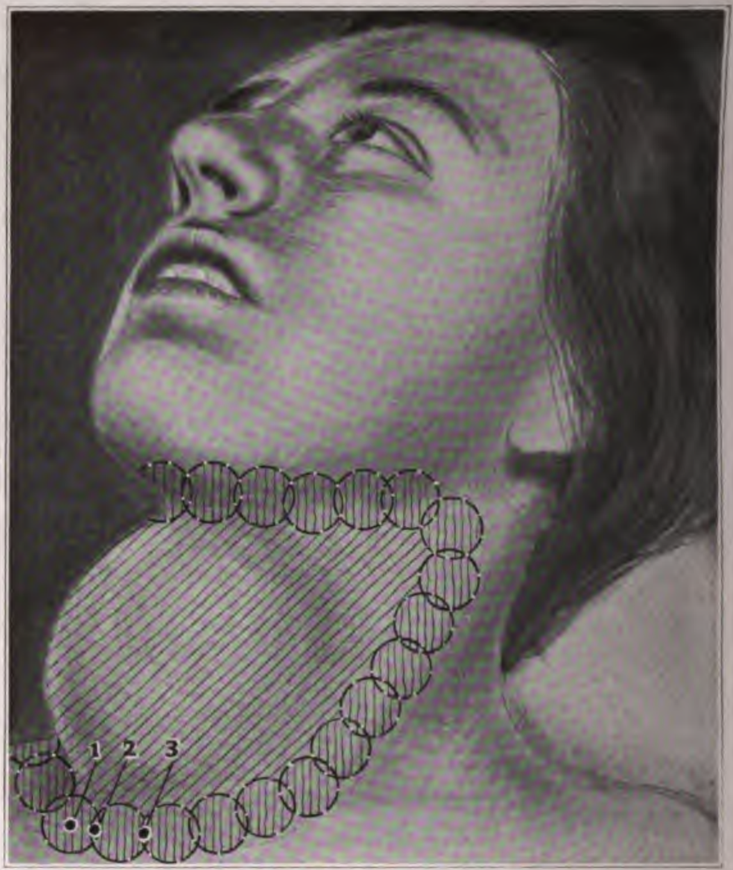


Fig. 536.—Points of injection and area of anesthesia on left side for thyroidectomy. 1, Primary injection, 2 and 3, secondary injections.

Technic of Injection for Thyroidectomy.—To remove the thyroid gland under local anesthesia it is necessary to block the branches of the cervical plexus which supply the deep and superficial structures situated in the anterior region of the neck. The tissues located in the anterior region of the neck are supplied by the second, third, and fourth cervical nerves which divide into several branches illustrated in Figs. 532, 533 and 534.

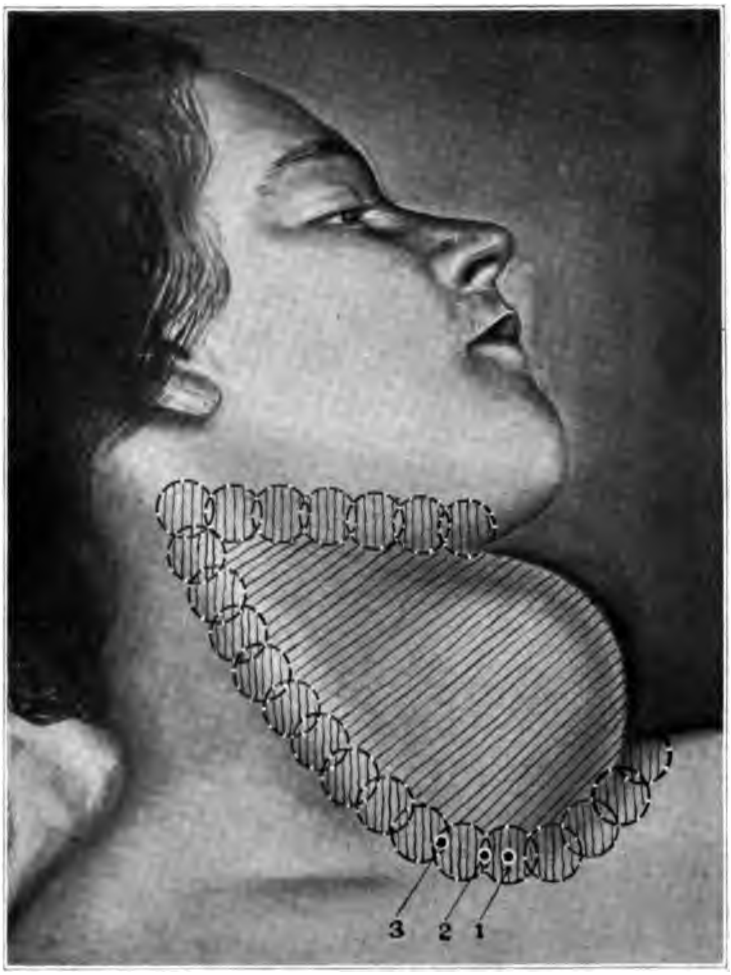


Fig. 537.- Illustrating points of injection and area of anesthesia on right side for thyroidectomy. 1, Primary injection, 2 and 3, secondary injections.

These nerves pass anteriorly from beneath the posterior margin of the sternomastoid muscle. It is not difficult to block the superficial branches above named by injecting the solution where they emerge from beneath the posterior surface of the sternomastoid muscle. Figs. 121, 532, 533, 534, and 538 show the cervical branches which are blocked. Both the deep block and circular infiltration methods are employed. The primary circular injection is made over the sternoclavicular articulation, injecting 2 mils of the solution. (See Fig. 536.) From this area the solution is injected along the posterior border of the sternomastoid muscle as indicated in Figs. 536 and 537, to a point 3 cm. below and posterior to the lobule of the ear. The solution is now injected beneath the chin along a line from the lower second molar tooth to the corresponding tooth on the opposite side. Following the circular injections, block the deep cervical branches by making three injections one-half inch apart at a depth of 1 cm. (see Fig. 538), the other injections being made more superficially.

These branches are blocked in the region of the transverse processes of the cervical vertebra. The solution is injected into the region of the cervical nerves located in the region of the third, fourth, and fifth cervical vertebra. In most cases only three injections are necessary. The upper injection is made approximately one inch beneath the tip of the mastoid process and at the posterior margin of the sternomastoid muscle. The third or lower injection is made on a line drawn lateral to the thyroid cartilage. The needle is passed into the deep tissues in the region of the transverse processes of the third, fourth and fifth cervical vertebra and 4 mils of a 1 per cent procain suprarenin Ringer solution is used for each of the injections. Anesthetizing the

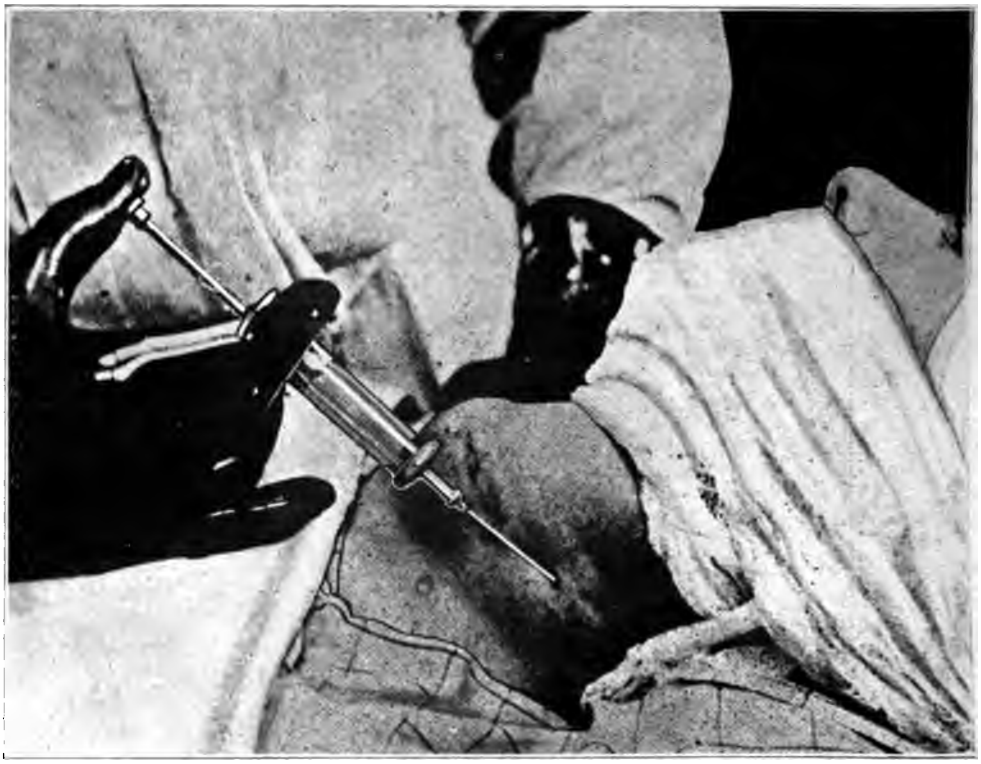


Fig. 538.—Blocking the cervical plexus by injecting the solution along the posterior border of the sternocleidomastoid muscle. (Retouched from Gwathmey.)

tissues by first, the circular infiltration method, and second, the deep block method was advocated by Hertzler. The blocking of the cervical branches over the transverse processes from the first to sixth cervical vertebra without the circular infiltration injections was advocated by Heidenhain and Braun.

If the operation extends near the median line, it is necessary to make three similar injections on the opposite side and in addition, employ the circular or infiltration method as indicated in Fig. 535. It will be noted from this illustration that the solution has been injected by the circular method extending from the right to left sides beneath the skin, which is to block the sensory branches from the third or mandibular division of the fifth nerve. It may be necessary to inject a small amount of solution posterior to the gland, and as deep as the esophagus. This is accomplished by inserting a long fine needle posterior to the carotid sheath and advancing it into the tissue. Instead of injecting the solution beneath the skin as illustrated in Fig. 535 the inferior dental and lingual nerves may be blocked at a point 1 cm. above the occlusal plane of the lower teeth. The carotid artery and jugular vein lie anterior to the point where the three deep injections are made, therefore care should be exercised not to injure them with the needle. Inject the solution as the needle is advanced through the tissues.

Amount of Solution Injected.—For each of the three deep injections, that is, three on each side, inject 4 mils. For each of the injections by the circular infiltration method which connects with the deep injection, inject 2 mils. These last named injections are made approximately 2 cm. apart. The total amount of solution injected for the superficial and deep block injections is approximately 45 mils of a 1 per cent procain suprarenin Ringer solution.

If the operation involves one side, only unilateral injections are necessary. However, if the operation involves the tissues nearer the median line, bilateral injections will be necessary. Ample time should be allowed for anesthesia to take place before operating.

BLOCK ANESTHESIA FOR THE REMOVAL OF THE CERVICAL LYMPH GLANDS

It is necessary in the removal of many malignant conditions of the tongue, lips and jaws, to remove the regional lymphatic glands. In most cases it is highly advisable to remove the glands at one operation, and after the wound has healed to operate for the removal of the tumor. If the glands are involved to a great extent and metastasis is considerable, causing a general involvement of the tissue, block anesthesia should not be employed.

It is the consensus of opinion among surgeons that it is poor practice to remove a malignant growth about the jaws, tongue, lips, etc., without first removing the regional lymph glands by a primary operation. The removal of the glands is merely a prophylactic measure, and when they are removed, there is less chance of the malignant growth returning.

The incision which is usually employed for the removal of the cervical glands is from the median line near the symphysis, extending posteriorly along the lower border of the mandible to a point posterior and below the lobule of the ear. In addition to this, an incision is made along the posterior border of the sternomastoid muscle. Anesthesia is produced for the removal of the cervical lymph glands in the same manner as above described for thyroidectomy.

CHAPTER XXXIII

BLOCK ANESTHESIA FOR TONSILLECTOMY; OPERATIONS UPON THE NASAL SEPTUM AND LATERAL NASAL WALL

BLOCK ANESTHESIA FOR TONSILLECTOMY

Topography of Anatomy.—The palatine tonsils are two bodies, one on each side, located upon the lateral wall of the oral part of the pharynx between the posterior and anterior pillars of the fossæ, 1½ cm. anterior to the internal carotid artery. The greater part of the triangular interval located between the glossopalatine and pharyngopalatine arches is occupied by the tonsils. (See Figs. 542.) At the upper part of the tonsil is a depression called the fossa supratonsillaris, which is covered by a fold of mucous membrane called the plica semilunaris. The sinus tonsillaris containing the tonsil is bounded anteriorly by the glossopalatine arch; posteriorly by the pharyngopalatine arch and inferiorly by the margin of the tongue and the apex of the triangle situated above and extending upwards to the side of the soft palate. (See Figs. 542, 543, and 546.) Upon examination it will be found that extending from the posterior pillar is a thin fold of mucous membrane, which is triangular in shape, known as the plica triangularis. This fold of mucous membrane passes downward and backward, some times overlapping the tonsils. Its lower border is attached to the tongue, while the mesial surface covers the lower part of the tonsillar fossa. The palatine tonsils differ in size and shape in different individuals, sometimes extending from the tonsillar fossæ into the pharynx, or they may be small and flattened, being wholly retained within the tonsillar fossa. In most cases the tonsils are oval in shape, each having a posterior and anterior margin, lateral and medial surface and a superior and inferior pole with the long axis vertical. The upper or superior pole is rounded, while the lower or inferior pole is more pointed and projects inferiorly towards the tongue. The palatine tonsils differ in size, but in early life they measure from 20 to 35 mm., from above downward; from 15 to 20 mm., anteroposteriorly; and 10 to 12 mm., mediolaterally. The lateral surface of the tonsil is enclosed in a fibrous connective tissue capsule and is attached to the fascia of the pharyngobasilar region. It is this connective tissue capsule which separates the base of the tonsil from the superior constrictor muscle of the pharynx. The medial surface of the tonsil is free and contains many orifices leading into recesses or crypts within the substances of the tonsil, which are also known as fossulae tonsillares.

The tonsils are composed mainly of lymphoid tissue containing many crypts with many lymph follicles, lymphatic vessels communicating with the deep cervical glands, blood vessels and connective tissue, and are covered with mucous membrane. Each tonsil is composed of masses of lymph cells surrounded by a reticulum of delicate connective tissue. The medial surface is covered with epithelium which is continuous with the epithelium covering the adjacent parts. This surface is very irregular and contains many crypts which are formed by deep enfoldings of the epithelial surface. The tonsil is entirely surrounded by a capsule composed of dense connective tissue with the exception of the free medial surface. Radiating from the capsule into the interior of the tonsil are trabeculæ composed of strong fibrous bands, which contain nerves, lymphatics and blood vessels. The crypts formed by the growth of the epithelium covering the free surface of the tonsil in most cases run deep into the adenoid mass and terminate near the capsule. In most cases the crypts become smaller as they penetrate the tonsils, but communicate with each other, while near the surface they are more numerous and larger. The anterior pillar or fauces arches downward and forward to the base of the tongue and contains the palatoglossus muscle. The posterior pillar or fauces arches downward and backward to the side of the pharynx and contains the palatopharyngeal muscle.

The Blood Supply of the Tonsil.—The arteries supplying the tonsils are the deep dorsalis lingulæ branch of the lingual artery; the ascending palatine and tonsillar branches of the fascial artery; the ascending pharyngeal branch of the external carotid artery; the descending palatine branch of the internal maxillary artery and a branch from the small meningeal artery.

The Nerve Supply of the Tonsil.—The tonsil and surrounding soft structures receive their nerve supply from two different sources described as follows:

1. The tonsil receives a special branch from the glossopharyngeal nerve which unites with branches from the pharyngeal plexus to form the plexus tonsillaris. The pharyngeal branch of the vagus courses inward over the internal carotid artery and divides into branches which, conjointly with those derived from the glossopharyngeal and the superior cervical ganglion of the sympathetic nervous system, form the pharyngeal plexus. This plexus often contains one or more small ganglia and its filaments supply muscles, mucous membrane, tonsils, etc. The pharyngeal plexus is formed by the pharyngeal nerves uniting with branches from the vagus opposite the middle constrictor muscle.

2. Middle and posterior palatine branches which are derived from Meckel's ganglion.

The Glossopharyngeal Nerve.—The nervus glossopharyngeus, or ninth cranial nerve, is mixed, it being a sensory nerve and one of special sensation. It arises from three or four filaments from the medulla oblongata in the groove situated between the olivary and restiform bodies. (See Figs. 44 and 46.) This nerve makes its exit from the cranial cavity together with the tenth cranial or vagus and accessory nerves through the jugular foramen and is surrounded by a separate sheath of dura mater. After it passes out of the jugular foramen, (Fig. 47) it arches downward and forward in the neck to a point between the mandible and hyoid bone, it then passes around the outside of the stylohyoid ligament and stylopharyngeal muscle, then below the hyoglossus muscle, and terminates in the tongue. This nerve supplies the stylopharyngeus muscle and gives off important branches to the pharyngeal plexus. In addition it sends fibers to the mucous membrane of the pharynx and another branch forms the plexus tonsillaris supplying a portion of the tonsil and mucous membrane covering the same, as well as the mucous membrane located in the immediate region of the tonsil. This nerve supplies the mucous membrane of the fauces and the base of the tonsil. Its branches are classified in three different series and are named in accordance with their origin. 1. In the jugular foramen. 2. In the neck. 3. In relation to the tongue.

We will not attempt to enumerate here the branches given off in the region of the jugular foramen but will dwell somewhat upon the branches in the neck and their relation to the tongue, which are as follows: The glossopharyngeal nerve gives off two branches in the neck.

First, as this nerve passes above the stylopharyngeus muscle it gives off a branch called the ramus stylopharyngeus which supplies the muscle of the same name. Small branches pass outward to supply the mucous membrane of the pharynx.

Second, the pharyngeal branches supply the mucous membrane lining the pharynx, and, indirectly, after joining the small pharyngeal branches given off the vagus and the superior cervical ganglion of the sympathetic, assist in forming the great pharyngeal plexus. The terminal branches of the glossopharyngeal nerve supply the mucous membrane of the tonsil and other adjacent parts. A tonsillar branch is given off which forms the tonsillar plexus supplying the mucous membrane covering the tonsil, a portion of the soft palate and palatine arches. The dorsal third, lateral half of the tongue and glossoepiglottic border are supplied by several lingual branches.

To recapitulate: The branches of the glossopharyngeal nerve are as follows:

1. Two linguals, one to the base and one to the posterior half of the tongue, being distributed to the mucous membrane, the papillæ and follicular glands.
2. The tonsillar branches forming the tonsillar plexus, which supply the mucous membrane covering the tonsil, the soft palate and the fauces.
3. The muscular branch, to the stylopharyngeal muscle.
4. The pharyngeal, to the pharyngeal plexus.
5. The carotid branches which pass along the internal carotid artery.
6. The tympanic branch which supplies the structures within the region of the ear.

The Pharyngeal Plexus.—The pharyngeal plexus is composed of numerous nerve branches derived from the vagus and glossopharyngeal nerves and from the superior cervical ganglion of the sympathetic nervous system. It is composed of a meshwork of fine nerve filaments located upon the wall of the pharynx, beneath the mucous membrane on a level with the middle constrictor muscle. The branches of the glossopharyngeal, vagus, and the superior cervical ganglion unite to form the pharyngeal plexus and in addition a few other small ganglia are formed. Branches are given off from this plexus which supply the muscles and mucous membrane of the pharynx and palate and are both motor and sensory.

The Tonsillar Plexus.—The tonsillar plexus is more superficial than the pharyngeal plexus and is situated at the base of the tonsil, supplying the capsule and mucous membrane covering the tonsil, the adjacent parts of the soft palate, palatine arches, and other tissues in this immediate region. The tonsillar plexus is formed by the branches from the glossopharyngeal nerve and the pharyngeal plexus.

The Middle and Posterior Palatine Branches of Meckel's Ganglion.—A complete description of Meckel's ganglion and its branches will be found in Chapter VII. The nerve supply of the tonsil and immediate region, in addition to the tonsillar and pharyngeal plexus, is supplied by the middle and posterior palatine branches derived from Meckel's ganglion. (See Figs. 40 and 60.) The middle and posterior branches pass downward through the palatine canals. The middle palatine, after emerging from the canal, divides into numerous branches supplying the mucous membrane of the uvula, soft palate and palatine tonsils. This nerve passes posteriorly into the soft palate and covers the tensor veli palatini. The posterior palatine nerve passes from Meckel's ganglion downward and forward, giving off small branches supplying the soft palate, mucous membrane, tonsil and uvula. It emerges from its canal lateral to the middle palatine branch, being somewhat smaller than the middle palatine nerve. Gray states that in some cases it may be entirely absent.

The anterior palatine nerve, which is the largest of the three palatine branches, is also a branch of Meckel's ganglion and descends through the pterygopalatine canal, entering the palate through the posterior palatine foramen, taking a course anteriorly lingual to the apices of the lingual roots of the three upper molars and bicuspid teeth, overlapping the branches of the nasopalatine nerve lingual to the apex of the cuspid tooth, thus forming the inner nerve loop. (See Figs. 80 and 81.)

The posterior palatine nerve divides into numerous branches supplying the mucous membrane, gum tissue and periosteum of the hard palate and the soft palate.

RECAPITULATION OF THE NERVE SUPPLY OF THE TONSIL

1. From the middle and posterior palatine branches derived from Meckel's ganglion.

2. From the pharyngeal and tonsillar plexuses derived from the glossopharyngeal or ninth cranial and the vagus or tenth cranial.

THE REMOVAL OF TONSILS UNDER BLOCK ANESTHESIA

The removal of the tonsils has become a common operation within recent years because modern research work has revealed the ill effects derived from retaining the tonsils after they have become diseased. Since the discovery that the tonsils harbor virulent bacteria and their entrance into the circulation causes them to be carried into distant regions causing arthritis, and neuritis; and especially endocarditis and other serious pathologic conditions by being carried into the endocardium, it is imperative that diseased tonsils be removed to preserve the health of the patient. It is not intended here to go into the technic of surgery for the removal of the tonsils, but it is necessary to dwell upon certain factors with reference to the blocking of this area.

There are two types of operations, which are called tonsillectomy and tonsillotomy.

Tonsillectomy.—There is no question but that the method of tonsillectomy should be the operation of choice, the technic having been principally developed by the specialists of America. It is a question not to be argued that the stump, or base of the tonsil which is left following a tonsillotomy is just as dangerous, if not more so, than the entire tonsil was before the patient was subjected to operation. By tonsillectomy, the complete removal of the tonsil with its capsule is effected and no remnant is left which can harbor bacteria, to enter the circulation. We have no certain knowledge of the function of the tonsil, neither does its presence seem necessary for good health. Its complete removal does not in any way appear to be injurious, so there should be no hesitancy in removing diseased tonsils. Tonsillotomy is not the kind of operation which is performed for the removal of the tonsils by the leading American specialists, but it is still employed by many laryngologists in Europe. The majority of American throat specialists recommend tonsillectomy and condemn tonsillotomy, claiming that it is positively harmful. When tonsillotomy is employed, the entire tonsil is not removed with its capsule, but a portion is left in the tonsillar fossa which in most cases causes future complications. The mere incising of the tonsil where it projects medially between the anterior and posterior pillars is wholly inadequate and dangerous for the future health of the patient. The amount of the tonsil removed depends on the skill of the operator, and the technic employed. If the tonsil is not situated deeply in the tissue between the anterior and posterior pillars, it is possible for the operator to entirely remove it with its capsule by tonsillotomy. However, it is the writer's opinion that tonsillotomy should be condemned by all physicians and dentists, and complete enucleation performed.

Preparation of the Patient for Operation.—If the tonsil is acutely inflamed or the patient is suffering from a sore throat, operation for the removal of the tonsils must be deferred until inflammation has subsided. It is important that the same general principles be observed in the preparation of the patient for tonsillectomy as for a surgical operation, where a general anesthetic is to be employed. It is also good practice and highly important to be thorough in the preparation of the patient prior to the time of operating by nerve blocking anesthesia.

Tonsillectomy is a hospital operation. It is much better to have patients in a hospital than it is to operate upon them in the home or the office. With young children it is not always necessarily a hospital operation, because the operation is rarely followed by sepsis or severe hemorrhage. However, in adults, it should always be a hospital operation on account of possible sepsis and postoperative hemorrhage. A thorough physical examination should be made of the patient's throat, heart and lungs, and should this examination reveal inflammation of the mucous membrane surrounding the tonsils, or a sore throat, the operation should not be performed. The crypts of the tonsil should be thoroughly cleansed by removing any necrotic material with a swab and by syringing with warm saline solution or the application of a silver nitrate or argyrol solution. Treatment should be employed to prepare the tonsils so that the operation can be performed without danger of infection. It is of the utmost importance that the specialist prepare the tonsils for operation and give them just as much consideration as he would any other part of the body. The rules of asepsis should always be applied to the larynx, throat and nose, even if this location is not susceptible to absolute surgical cleanliness. A thorough physical examination should always be made to ascertain the exact condition of the heart, lungs and kidneys, and it is always well to test the coagulation time of the blood. The patient should have a saline cathartic, producing thorough evacuation before operation; a high colon soap suds enema should be given, and the patient should have only a light supper consisting of liquids the evening before operation and no breakfast on the morning of the operation. In case the coagulation time of the blood is increased, 10 grains of calcium lactate are administered every four hours for at least twenty-four hours before operation. A preliminary hypodermic is given one-half hour before blocking or operating, consisting of $\frac{1}{8}$ to $\frac{1}{4}$ gr. morphin, $\frac{1}{150}$ gr. scopolamin and $\frac{1}{40}$ gr. strychnin, which relieves the patient of anxiety and uneasiness.

Anesthesia for Tonsillectomy.--There are two methods: first, general anesthesia; second, block anesthesia. The technic for administering a general anesthetic for the removal of the tonsils will not be given in this text. We will only consider block anesthesia for this operation.

Block Anesthesia for Tonsillectomy. Since the advent of local anesthesia, it has been used by many operators for removal of the tonsils. During the past few years the use of local anesthesia for this operation has been steadily growing in popularity and at the present time fully 75 per cent of the tonsillectomies are performed under local anesthesia. The method which has been employed has been that of infiltration, the use of which many times does not conform to the strict laws of asepsis. It is a fact that many times the tonsil is a mass of degenerated tissue consisting of necrotic material and pus. The principal composition of the tonsil is that of lymphatic tissue containing many crypts, and when infected it undergoes degeneration very easily and is an excellent place to harbor bacteria and toxins. The direct connection existing between the tonsil, the arterial and lymphatic circulatory systems allows the toxic material to be absorbed and carried to distant parts. In many cases this causes an impairment of the general health, often producing infectious diseases, such as endocarditis and arthritis.

The method used by most operators of anesthetizing the tonsil and surrounding tissues is that of infiltration anesthesia; that is, simply inserting the needle around the tonsil in the anterior and posterior pillars of the mucous membrane covering these parts and injecting the solution without any definite technic as to the insertion of the needle. *A modern operator, who has been properly trained, will never be guilty of inserting a needle into inflamed tissue or an abscess and injecting the solution in an attempt to produce anesthesia.* Many times the author has observed operators inserting the hypodermic needle into inflamed and necrotic tonsillar tissue, injecting the solution and disregarding inflammation and infection. Such a procedure is not modern surgery and not in accordance with the laws of bacteriology, pathology or asepsis. Instead of inserting the hypodermic needle into an abscessed area or inflamed tissue, the careful operator will make deep block injections into the nerve trunk supplying the infected area, the solution then being injected into healthy tissue at a point distant from the field of operation.

During the past four years the writer has spent considerable time in perfecting a block anesthesia technic for tonsillectomy. This was accomplished following the careful dissection of a number of cadavers, becoming familiar with the nerves supplying the tonsils and their relation to the surrounding structures. The findings along this line have been very satisfactory, and it is a pleasure to present the technic for blocking tonsils to the eye, ear, nose and throat specialists. There is no comparison between the efficiency of the deep nerve blocking method and the infiltration method, where the solution is injected promiscuously into the tissue, which many times causes a dissemination of the infection and carries infected material into healthy tissue. Before attempting to block the nerve supply of the tonsils by the deep nerve block method, the operator should be thoroughly familiar with the nerve supply of the structures and the technic in all of its phases.

The Tonsillar Needles and Extension Hub.—A tonsillar extension, shown in Fig. 208, is employed, which eliminates placing the barrel of the syringe in the patient's mouth during the insertion of the needle. Needle No. 4, 25 gauge, and 30 mm. in length, iridio-platinum, is used with the tonsillar extension, to block the pharyngeal and tonsillar plexuses. (See Fig. 177.)

Needle No. 6 is employed for blocking the sphenopalatine ganglion (Meckel's ganglion). The needle shown in Fig. 177 is 40 mm. in length, which is used for blocking 2nd Division (Intra Oral) therefore 5 mm. is cut off, making it 35 mm. in length, and is then used for tonsil blocking.

Technic of Injection.—*Position of Patient.*—The patient can be either placed in a semisupine position in the operating chair, or preferably upon the operating table in a horizontal position while the deep block injections are being made. It must be remembered, when a patient is in a semisupine or horizontal position, more solution can be injected with less chance of producing syncope or toxic symptoms. This position is much preferred to the upright position, as practiced by many operators.

Preliminary Treatment Prior to Making the Deep Block Injection.—The mucous membrane in the mouth and tonsillar region is swabbed with gauze held in artery forceps, in order to remove saliva and mucus as thoroughly as possible. (See Fig. 219.)

The first step in the technic for blocking the tonsil is to allay sensibility in the region of the tonsil, to prevent gagging and to eliminate the sting of the needle while it is being inserted into the tissue. This is accomplished by applying the following combination to the tonsil, anterior and posteror pillars and soft palate, with cotton wrapped around a metal applicator or by artery forceps.

℞ Procain powder,
Adrenalin hydrochlorid.

The cotton applicator is dipped into a solution of 1/2000 adrenalin hydrochlorid and after squeezing out the excess, it is dipped into the receptacle containing procain powder, after which the mucous membrane covering the tonsil, anterior and posterior pillars and soft palate, is thoroughly swabbed. If difficulty should be encountered in dissolving the procain crystals, with the cotton which is moist with adrenalin hydrochlorid, the following solution, which is 20 per cent, may be used.

	Gm. or Mil
℞ Procainæ pulvis	6
Phenolis 95%,	2
Adrenalin hydrochlorid 1/1000 sol.	10
Aqua dest., q. s. ad	30
Misce.	

Sig.: Dip the cotton swab into the solution and carefully apply to the mucous membrane. At least, five applications, with an interval of five minutes between each application, should be made and, if properly done, will allay the hypersensitiveness and gagging while making the deep block injections. The operator should allow sufficient time to elapse between each application, as the production of surface anesthesia will save much time in executing the rest of the technic.

Preparation of the Mucous Membrane. For blocking of the pharyngeal plexus, the mucosa is prepared for the needle by applying a 3½ per cent tincture of iodin solution over the tonsil and anterior pillar. It is also applied distal to the tuberosity for blocking the anterior, middle and posterior palatine branches at Meckel's ganglion. Two deep injections are made, and are named in the order in which they are used:

1. Blocking the spheno-palatine ganglion (Meckel's).
2. The pharyngeal and tonsillar plexuses.

Technic for Blocking the Sphenopalatine (Meckel's) Ganglion.—A special needle is employed for blocking the sphenopalatine ganglion. It is the same as the one used for blocking the second division of the fifth nerve by the intraoral method, with the exception that the needle is 5 mm. shorter, this making the needle 3½ cm. in length. (See Fig. 177.) The hub is 4 cm. in length, and has a curvature sufficient to allow the needle to pass over the tuberosity in the right direction. The syringe is held in the hand pen fashion, the needle is inserted into

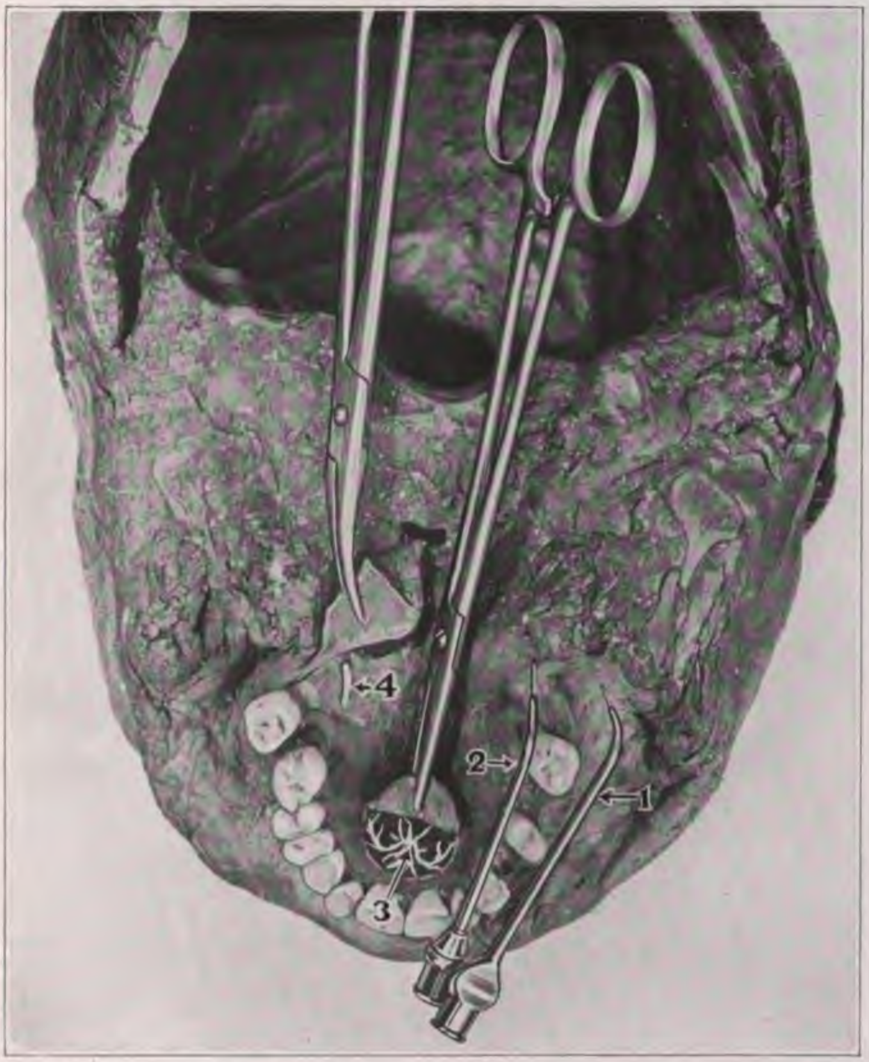


Fig. 539.—Wet anatomic specimen illustrating the following:

1. Position of needle (in mucous fold buccal to third molar) for blocking second division of fifth nerve by intraoral method.
2, Position of needle (Posterior to tuberosity) for blocking the sphenopalatine ganglion (Meckel's).
3, Right and left nasopalatine nerves as they emerge from the anterior palatine foramen.
4. Anterior palatine nerve emerging from posterior palatine foramen.

the mucous membrane distal to the upper third molar, or, in other words, distal to the tuberosity of the superior maxillary bone. (See Fig. 539.) The needle is advanced upward, inward and backward to an approximate depth of 2½ cm. for adults or 1½ cm. for children. The amount of solution injected on one side is 4 mils of a 1 per cent; with children 2½ mils. When the solution is injected the point of the needle should be at the sphenopalatine ganglion which is located from 5 to 7 mm. beneath the 2nd division and midway between the posterior part of the tuberosity of the superior maxillary bone and the anterior surface of the greater wing of the sphenoid bone. (See Figs. 48, 60, and 98.) The hub and extension of the needle rests upon the occlusal plane of the upper teeth, as shown in Figs. 540 and 541. The approximate depth of the needle is 2½ cm. The needle employed being 3½ cm. in length, 1 cm. will remain exterior to the surface mucosa. This injection will block the sphenopalatine ganglion and its branches. (See Figs. 48, 60, and 98 for these branches.)

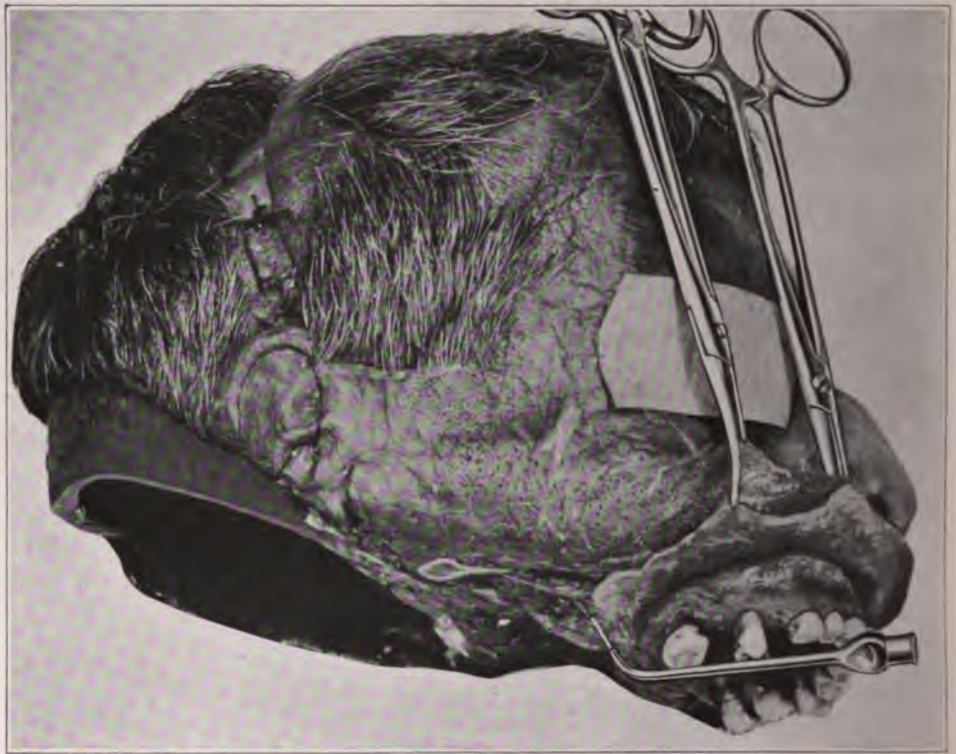


Fig. 540.—Wet anatomical specimen illustrating the position of needle for blocking the sphenopalatine (Meckel's) ganglion. Note that the needle is inserted just posterior to tuberosity and that the extension hub is resting upon the occlusal plane of the teeth.

Blocking the Pharyngeal and Tonsillar Plexuses.—The pharyngeal and tonsillar plexuses and their branches, located postero-laterally to the base of the tonsil, are now blocked. For this injection an extension hub is mounted upon the syringe to facilitate making the injection without placing the syringe in the patient's mouth. Upon the extension, place needle No. 4, 25 gauge, and 30 mm. in length. (See Fig. 177.) First locate the position of the plica semilunaris, which is a fold of mucous membrane and a part of the anterior pillar. Two imaginary horizontal lines are now drawn which are illustrated in Fig. 542. The upper line is drawn on a level with the upper pole of the tonsil indicated by 3. The lower line is drawn on a level with the lower pole of the tonsil indicated by 2. An imaginary perpendicular line indicated by 1 is now drawn through the base of the tonsil connecting with the two transverse or horizontal lines. Two injections are made which are illustrated by x in Figs. 542, 543 and 544. The upper injection is made first. The syringe

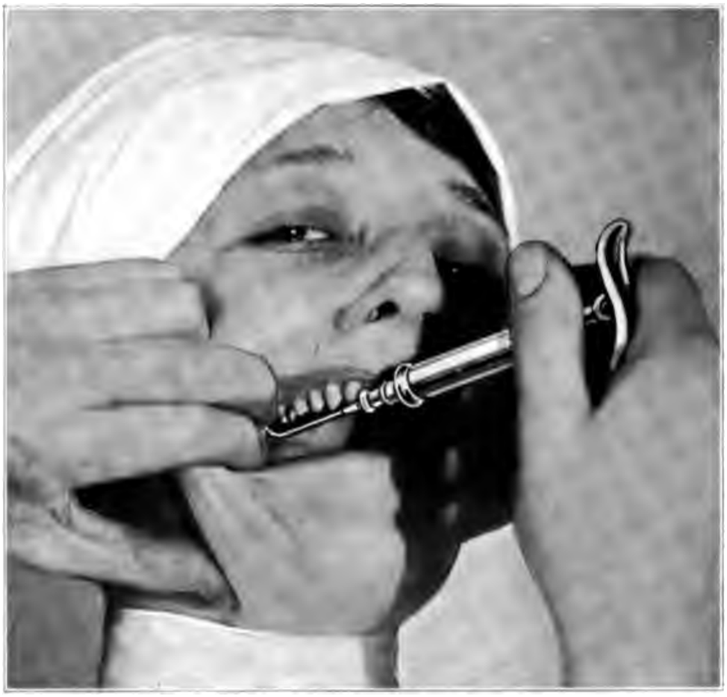


Fig. 541. Position of syringe and extension hub while injecting the sphenopalatine ganglion.

is held pen fashion and is allowed to assume a position across the mouth in the region of the bicuspid teeth, as illustrated in Fig. 545. The needle is advanced through the anterior pillar indicated by x in Figs. 542, 543, and 544 to a depth of ½ cm. and one-half mil of the solution is injected, after which the syringe is extended across the median line on the same side of injection, until the extension hub is buccal to the occlusal plane of the lower teeth, as is illustrated in Figs. 543 and 546. The needle is now advanced 5 mm. further into the tissue and one-half mil of the solution is injected. Again advance the needle 5 mm. and inject one-half mil of solution; now advance the needle 5 mm. further, which makes a total depth of 2 cm., and at this point inject 1 mil of the solution. The direction of the needle, after the syringe is extended across the median line on the same side of injection, should be backward and on a level with the transverse plane drawn through the head. If the needle has been inserted correctly to a depth of 2 cm., the last mil of solution will be injected into the region of the pharyngeal and tonsillar plexuses and their branches. The needle should never be inserted deeper than 2 cm. in adults or 15 mm. in children. It will be noted that the puncture point for the

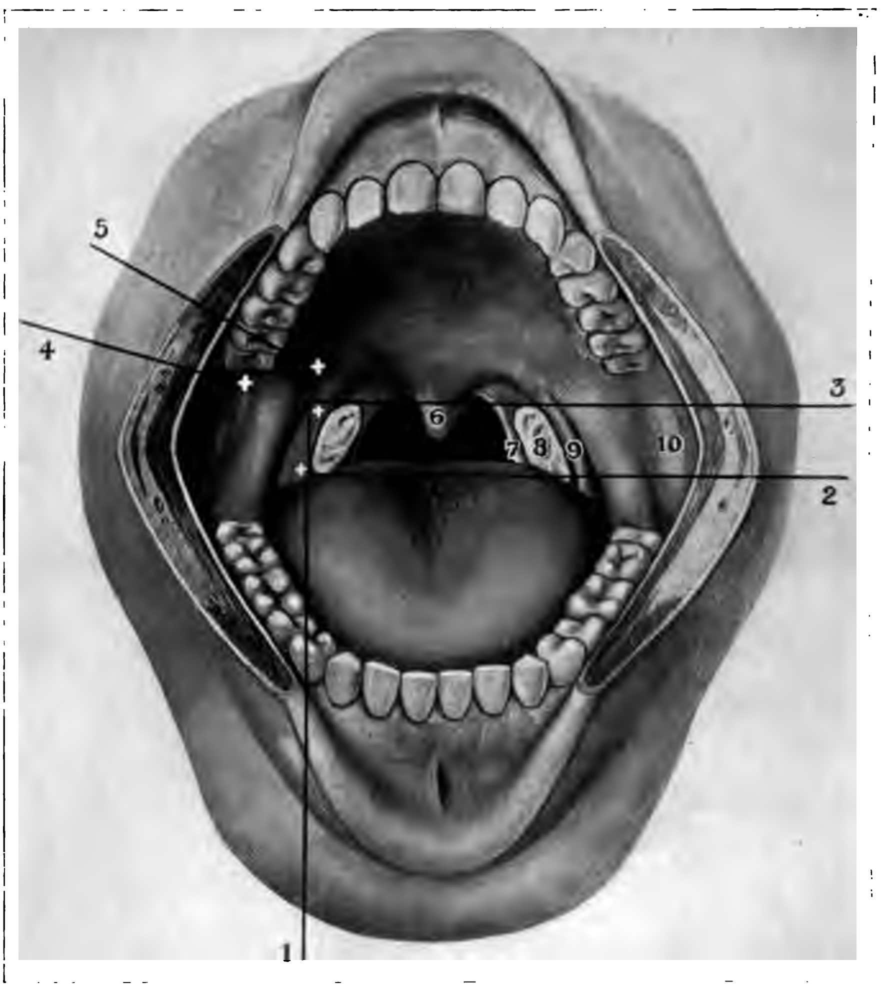


Fig. 542.—Illustrating points of block injections for anesthetizing the tonsillar region.

1. Perpendicular line passing through base of tonsil which connects with the two horizontal lines. 2, Horizontal line passing through lower pole of tonsil. 3, Horizontal line passing through upper pole of tonsil. 4, Location for starting needle for blocking the sphenopalatine ganglion (indicated by X). 5, Location of posterior palatine foramen and exit of anterior palatine nerve (indicated by X). 6, Uvula. 7, Posterior pillar or fauces. 8, Tonsil. 9, Anterior pillar of fauces. 10, Mucosa located anterior to ascending ramus. X. The upper and lower X's located near angles formed by the perpendicular and horizontal lines indicate the two points for insertion of needle for blocking the pharyngeal and tonsillar plexuses.

upper injection is located just medial to the angle formed by the upper horizontal and perpendicular lines. (See Fig. 542.) The lower injection is made in the same manner as already described for the upper injection, with the exception that the puncture is made lateral to the angle formed by the lower horizontal and perpendicular lines. (See Figs. 542, 543 and 547.) The needle is inserted through the anterior pillar for both injections.

Recapitulation of the Injection of Solution.—The amount of solution used at the various sites of injection is as follows. Each quantity is named in the order in which it is employed:

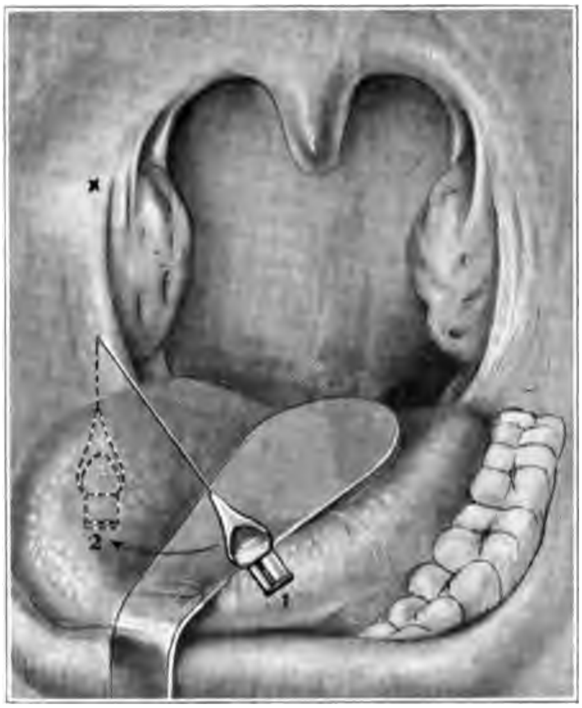


Fig. 543. Illustrating the tonsils, anterior and posterior pillars.

1, Position of needle for lower injection as it enters the anterior pillar and 2, shows it in position at depth of 2 cm. for blocking the pharyngeal and tonsillar plexuses. The arrow indicates how the needle extended to the buccal of the lower teeth. X represents starting point for upper injections.

1. Five applications of a 20 per cent procain suprarenin Ringer solution to the palate, tonsil, anterior and posterior pillars by the swabbing method at intervals of three minutes. (See formula, page 772.)	
2. For sphenopalatine ganglion (Meckel's) and branches	4 mils
3. For the pharyngeal and tonsillar plexuses and their branches: Upper injection 2½ mils; lower injection 2½ mils. Total	5 mils
Total amount for one side	9 mils
Total amount of a 1 per cent procain suprarenin Ringer solution for both sides..	18 mils

Time to Wait for Anesthesia.—At least three minu
tween each application for producing surface anesthesia
deep block injections. Anesthesia is produced in 15 minu
plied by Meckel's ganglion and its branches following
least fifteen minutes must elapse after injecting the solu
pharyngeal and tonsillar plexuses postero-laterally to t

Structures Anesthetized.—The blocking of the sph
produces anesthesia of the tissues supplied by the br
ganglion. *The object of blocking the sphenopalatine g*
tomy is to anesthetize the anterior, middle, and posteri

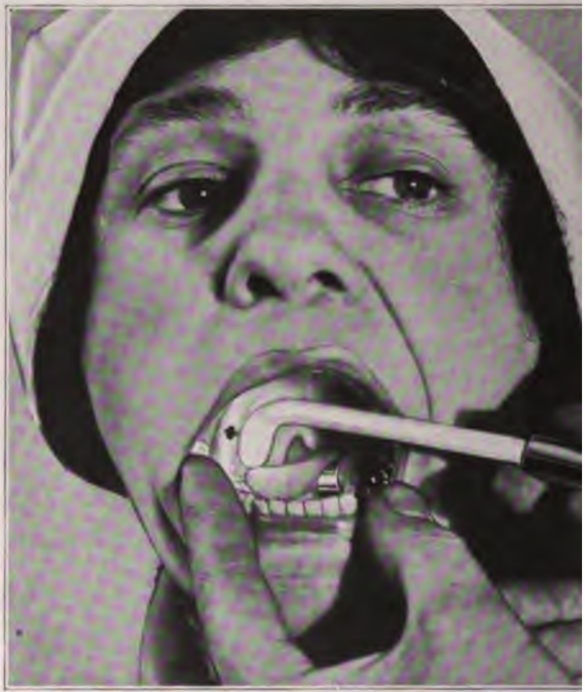


Fig. 544.—Illustrating the starting point of needle for blocking pharyngeal a
dicates the point for the upper injection.

but in addition to these branches the nasopalatine, superi
geal branches are anesthetized. The blocking of the
palatine branches anesthetizes the soft palate, uvula, m
a portion of the anterior and posterior pillars and tonsil
tine nerve will anesthetize the tissues at the junction
palates over and anterior to the posterior palatine forame
tissues, and periosteum will be anesthetized along the lin
far anteriorly as the lingual surface of the cuspid. Th
will be blocked, which anesthetizes a portion of the na
tissue and periosteum lingual to the central, lateral and

it meets the anesthesia from the anterior palatine nerve and completes the anesthesia of the inner nerve loop. Anesthesia of the hard and soft palates, which is secured by blocking the inner nerve loop, is advantageous as it helps to eliminate gagging while operating. It is not necessary that the nasopalatine nerve be blocked for tonsillectomy, but it is not possible to prevent anesthetizing it in view of the fact that the sphenopalatine ganglion is injected. *The blocking of the pharyngeal and tonsillar plexuses and their branches anesthetizes a portion of the anterior and posterior pillars, a portion of the tonsil, the tonsillar capsule, and the tissues located lateral to the base of the tonsil.*

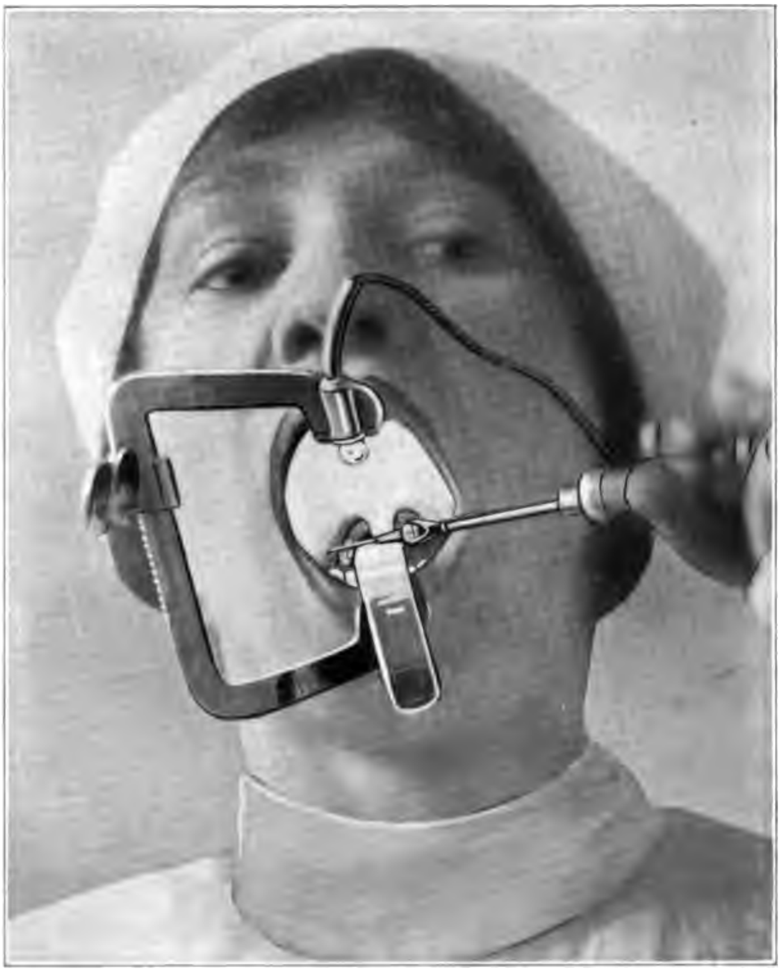


Fig. 545.—First position of syringe and needle for making the upper injection for blocking the pharyngeal and tonsillar plexuses.

Precautions.—The precautions which should be taken during the blocking of the tonsils are as follows: At least five applications of a 20 per cent procain adrenalin Ringer solution should be applied, allowing at least three minutes to elapse between each application, to eliminate the hypersensitiveness of the tissue while inserting the needle for the deep block injections and to prevent gagging. The mucous membrane in the region of the tonsil, soft palate, pharynx and larynx is hypersensitive in the majority of people and reacts to the slightest irritation, thereby causing straining and gagging. Therefore, the operator should not overlook this important factor and attempt to make the deep block injections before sufficient time has elapsed to allow the anesthetic to produce surface anesthesia. Great care should be exercised to prevent sudden movement of the patient while inserting the needle posterior to the tuberosity of the superior maxillary bone for the blocking of the sphenopalatine ganglion and branches; also while injecting the pharyngeal and tonsillar plexuses, which

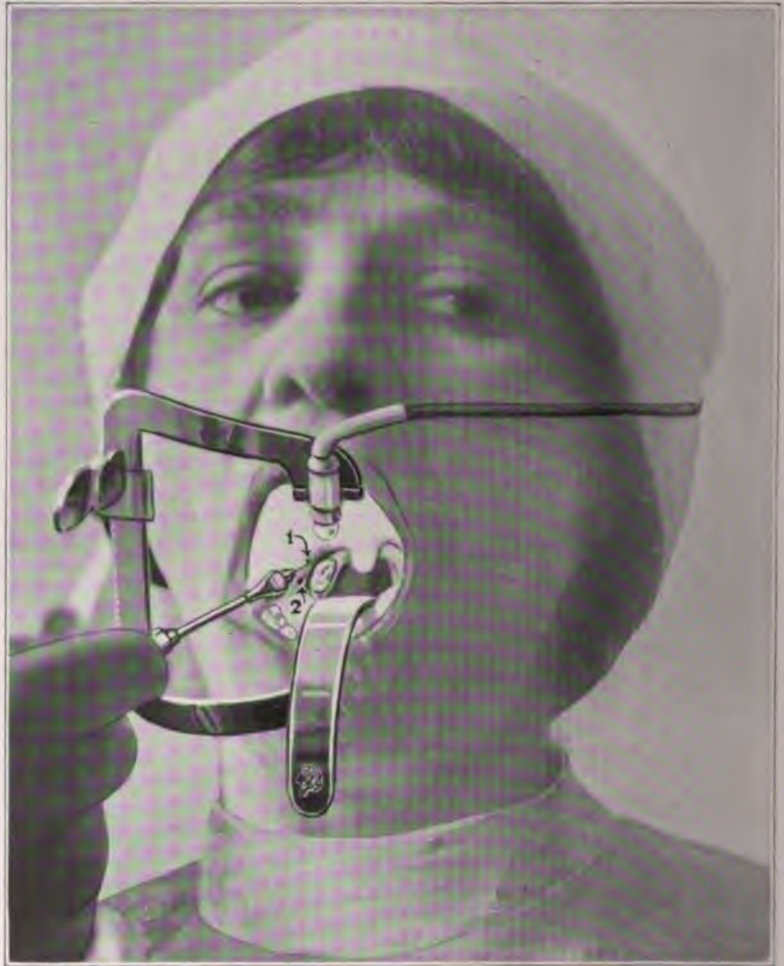


Fig. 546.—Second position of syringe and needle for making the upper injection for blocking the pharyngeal and tonsillar plexuses.

1 and 2 represent the starting points located in the anterior pillar.

might result in breaking the needle. The direction of the needle for blocking the pharyngeal plexus is backward on a transverse plane drawn through the head. The extension hub and syringe should never be allowed to assume a position lingual to the lower teeth on the same side of injection, for if the syringe is held in that position the needle would be advanced backward and too far laterally. An extreme lateral position must be avoided as well as the insertion of the needle deeper than 2 cm., in order to avoid deep blood vessels and the vagus nerve. The needle employed for the blocking of the plexuses is 3 cm. in length, and the average depth of its insertion for an adult is 2 cm. Therefore 1 cm. is allowed to remain in full view and exterior to the surface of the tissue at the puncture point.

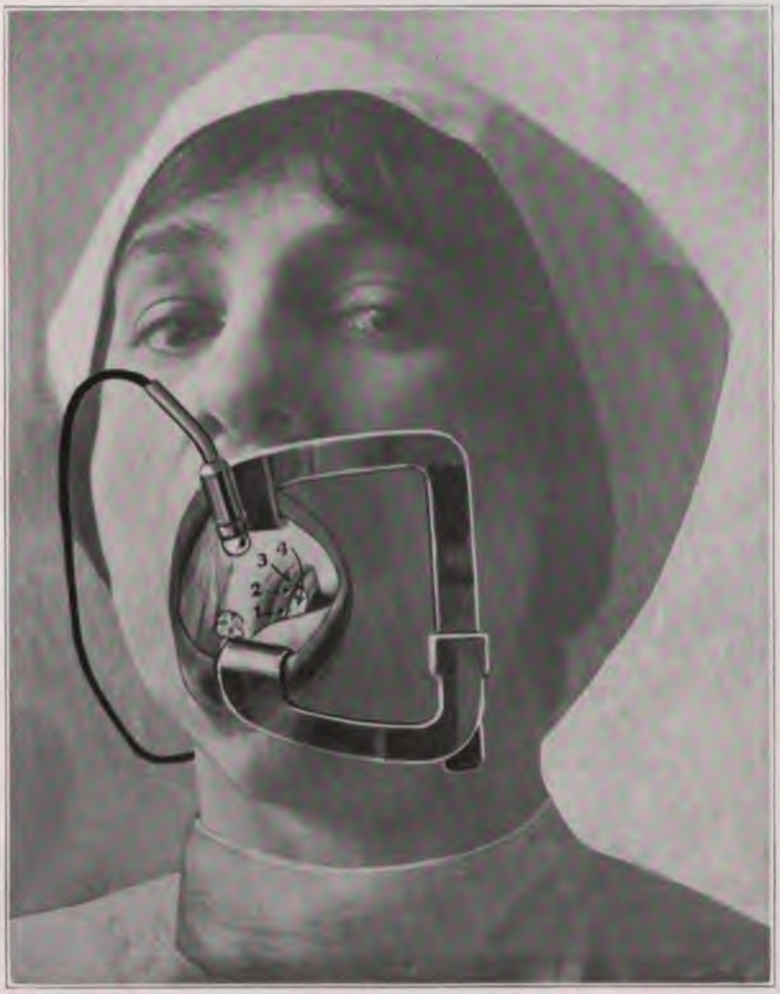


Fig. 547.—Illustrating the region of tonsil. 1 and 2 starting points for upper and lower injections in region of pharyngeal and tonsillar plexuses. 3, Anterior pillar. 4, Tonsil.

Operating should never be attempted until at least fifteen minutes have elapsed following the injecting of the solution, and at this time perfect anesthesia of the entire area will be secured.

Operative and Postoperative Hemorrhage.—If the deep block injections have been made properly, the solution containing 1/50,000 of suprarenin, which is equivalent to 1/3200 of a grain per mil, there will be very little or no hemorrhage during or after the operation. It has been the author's experience with this technic that very little hemorrhage is ever experienced; in fact, in some cases the tissues at the site of operation are scarcely covered with blood. The reason for the lack of hemorrhage no doubt is due to the fact that the solution is injected into the healthy tissue at a point distant from the operative area, and the suprarenin exerts a more powerful action upon the arterioles and blood vessels in the part injected than if the solution was injected into an inflamed or infected tissue in the immediate tonsillar region.

Another factor which may prevent hemorrhage to a considerable extent is that little or no solution is lost during the operation, because it is injected at a distant point and not into the operative tissue. In other words, all the solution which is injected is retained.

ADVANTAGES OF THE DEEP BLOCK METHOD FOR TONSILLECTOMY

1. The area of operation is blocked by anesthetizing the nerve branches in the healthy tissue at a point distant from the operative field.
2. The needle is not inserted into inflamed or infected tissue.
3. When the nerves are blocked in healthy tissue at a distant point from the operative field, the toxins or infected material are not forced into the healthy tissue.
4. Postoperative hemorrhage is much less when utilizing the deep block method than when infiltration anesthesia or general anesthesia is employed.
5. Very little or no pain is caused while making the deep block injections.
6. When these injections are properly made, no pain is experienced by the patient, and with little or no hemorrhage the operator has a clear vision of the entire operative area and can take his time and do a complete enucleation, thereby removing the entire capsule along with the tonsil. When the part is thoroughly blocked and with little or no hemorrhage, it is self-evident that the operator will employ all his skill in operating. When the tonsil with its capsule is thoroughly removed without pain and with a small amount of hemorrhage, it may be fittingly termed modern surgery and anesthesia in every respect.

BLOCK ANESTHESIA FOR SURGICAL OPERATIONS UPON THE NASAL SEPTUM AND TURBINATE BONES

The anesthetization of the nasal septum and turbinate bones is easily accomplished by the deep block method. By this method the tissues can be thoroughly blocked and the operation performed without discomfort to the patient. This method is of unlimited value to the rhinologist, not only from the standpoint of producing profound anesthesia of the operative field, but it makes it possible to operate cases in the office which, many times heretofore, were taken to a hospital and a general anesthetic administered.

Nerve Supply to Region of Nasal Septum and Turbinate Bones.—The nerve supply of the nasal septum is chiefly supplied by the nasopalatine branch given off the sphenopalatine ganglion. These nerves (right and left) supply the central and lower part. The posterior portion of the septum is supplied by small branches from the sphenopalatine ganglion. The anterior portion is supplied by the medial branch of the nasociliary nerve which is derived from the ophthalmic division.

The lateral nasal wall derives its nerve supply as follows: The upper posterior portion of the lateral nasal wall, from the posterior superior lateral nasal branches derived from the sphenopalatine ganglion; the lower posterior portion is supplied by the posterior inferior lateral nasal branch derived from the anterior palatine nerve; the anterior superior portion is supplied by the lateral nasal branch from the nasociliary nerve; the anterior inferior portion of the lateral wall, including the floor and anterior part of inferior meatus are supplied by a nasal branch derived from the anterior superior dental. (See Figs. 77, 79, 80, 92, 97, and 98.)

Technic for Blocking Nerves Supplying Nasal Septum.—As above stated the nerve supply to the nasal septum is derived from two sources: first, the principal supply from branches derived from the sphenopalatine ganglion; second, from the medial branch of the nasociliary nerve of the ophthalmic. The first injections made are the blocking of the right and left sphenopalatine (Meckel's) ganglion, employing the same technic as given on page 773 for blocking the tonsils. The blocking of the sphenopalatine ganglion anesthetizes all branches supplying the nasal septum with the exception of the medial branch of the nasociliary. The latter-named branch is blocked as follows: The nares are dilated by means of the nasal speculum. A needle of small calibre such as needle No. 4 (see Fig. 177) is employed. The needle is inserted into the mucosa covering the nasal septum just posterior to the lower border of the nasal bone. It is advantageous to draw an anterior posterior line; i. e., a line starting at the lower border of the nasal bones and extending posteriorly along the nasal septum. After the needle is started into the mucosa, approximately 5 mm. posterior to the lower border of the nasal bones (along the imaginary line) and is advanced approximately 15 mm. in an upward and posterior direction, two mils of a 1 per cent procain suprarenin Ringer solution is slowly and continuously injected from the time the needle enters the tissue until the proper depth has been reached. This injection will anesthetize the medial nasal branch of the nasociliary nerve within 5 minutes. The blocking of the right and left sphenopalatine ganglion and the right and left medial nasal nerves will produce a rapid and profound anesthesia for operations upon the nasal septum.

Technic for Blocking Nerves Supplying the Lateral Nasal Wall for such Operations as Resection of Turbinates.—As above stated the nerve supply to the lateral nasal wall is derived from three sources: first, from branches via the sphenopalatine ganglion; second, from the lateral nasal branch derived from the nasociliary of the ophthalmic; third, from a nasal branch derived from the anterior superior dental.

The first injection is to block the sphenopalatine (Meckel's) ganglion on the side of operation, employing the same technic as given on page 773 for blocking the tonsils. Next block the lateral nasal branch of the nasociliary as follows: The naris is dilated by means of the nasal speculum. A needle of small calibre such as needle No. 4 (see Fig. 177) is employed. The needle is inserted into the mucosa covering the lateral nasal wall at a point 5 mm. posterior to the lower border of the nasal bone. It is advantageous to draw an imaginary line posteriorly from the lower border of the nasal bone similar to that described above for blocking the nasal septum. After the needle is started into the mucosa at the above named point (along imaginary line) it is advanced approximately 15 mm. in an upward and posterior direction, and two mils of a 1 per cent procain suprarenin Ringer solution is slowly and continuously injected from the time the needle enters the tissue until the proper depth has been reached. The next injection is to block the nasal branch given off the anterior superior dental which is accomplished by making an infraorbital injection which technic is described on page 459. The blocking of the anterior superior dental may not suffice and it may be necessary to block the overlapping branches from the opposite side. If necessary, a tampon is placed in the anterior portion of the naris in contact with the anterior inferior part of the nasal wall. The tampon should be dipped in a 20 per cent solution of the anesthetic which has been described on page 772 and left in position for ten minutes, then removed and replaced with fresh solution and left again for ten minutes. The above injections will produce profound anesthesia so operations can be performed upon the lateral nasal wall.

CHAPTER XXXIV

NEURALGIAS OF THE TRIGEMINUS

The trigeminus is subject to two types of neuralgia; first, symptomatic pains; second, spasmodic pains, or tic douloureux. The symptomatic pains are by far the most frequent. They may be supraorbital, infraorbital, supramaxillary, intramaxillary, dental and mixed form. The most common type is the supraorbital, and next the mixed form.

The trigeminus or fifth cranial nerve is one of the most extensively distributed and most delicately sensitive nerves of the body. It supplies sensation to the face, conjunctiva, nose, frontal and maxillary sinuses, teeth, palate, tongue, and part of the upper pharynx; also to the scalp as far back as the vertex and to the external auditory meatus; gives sensation to three-quarters of the dura mater, falx, and probably the tentorium. In addition to the trigeminus supplying the above parts with sensation, it supplies them with trophic, vasomotor and secretory fibers. The vasomotor fibers are brought to it, in part, from the medulla and cervical spinal cord via the sympathetic. The secretory fibers have the same origin. The trigeminus nerve likewise supplies motion to the muscles of mastication. The sensory part of this nerve is subject to sensory neuroses, such as neuralgia, paresthesia, and anesthesia. Trigeminal neuralgia is closely related to dental practice, and aside from its etiological, diagnostic relation and treatment of the terminal reflex neuralgias, which are directly connected with maxillary and dental lesions, the complex problem of trigeminal neuralgia is essentially one which concerns the oral surgeon. (See Nervus Trigeminus, Chapter VII.)

Referred Pain.—Pain may be produced by either a distant or local cause, as, for example, an irritated or exposed pulp may cause pain in its immediate region as the nerves supplying the dental pulp are the peripheral endings of the large trunk through which pain impulses are transmitted; or the pain may be located at a distant point, such as neuralgia in the ear, occipital headache, etc., due to the direct relationship of the surrounding parts. It should be remembered that the area of referred pain is not sensitive to pressure if the pain is actually referred, but, if it is of local origin, the tissue in the immediate region is painful on pressure. Referred pain can be caused by pressure, injury, trauma, or irritation of a sensory nerve at a distant point. This stimulation is transmitted over certain sensory nerve branches to a remote part and there interpreted as pain. A good example is the common experiment of touching the face, striking the teeth, cheek or jaw, which many times will start severe paroxysms of pain at some distant point.

Another common example of referred pain which has been experienced undoubtedly by every dentist, is that the patient will complain of pain in a certain tooth and on examination, it will be found that it is perfectly healthy and free from caries or irritation and instead, a large carious cavity is found in the opposite jaw, the pain being referred by the connecting nerve branches. When the proper treatment is employed the patient is relieved. Many times it is difficult to convince the patient that the pain is not located in the tooth in which no pathology is present.

Neuralgia is a condition characterized by pain in the course of a nerve trunk or trunks; therefore, it is not a distinct disease but only a symptom and the modern trend is to discard this term, except to indicate a nerve pain. Many pains formerly called neuralgia were really due to neuritis, reflex irritation or to some form of organic disease, although there are a certain percentage of persistent nerve pains for which no organic etiology can be discovered. Therefore, both as a matter of convenience and necessity, we still cling to the term neuralgia. However, we attempt to classify it in accordance with its etiology and location. There are a number of neuralgias, such as hysterical, gouty, neuritic, cervical, trigeminal, brachial, etc. Neuralgia is also spoken of as symptomatic or idiopathic, according to whether we know or do not know the etiology of the pain. The careful and observing physician or dentist has little or no use for the term idiopathic, inasmuch as in most cases the basis of the pathology may be determined.

To illustrate the theory of referred pain, the writer will use, for example, the sensory root of the fifth nerve, situated between the Gasserian ganglion and its deep sensory nucleus which is located in the pons varolii and medulla oblongata. (See Figs. 43, 45, and 60.) This large sensory nucleus of the fifth nerve is highly complicated and extends from the knee-shaped bend in the pons varolii through the third cervical segment of the spinal cord. It also contains sensory fibers from which arise various branches of the fifth nerve, such as the ophthalmic, maxillary and mandibular, with their sub-branches. At this point, these sensory branches are in very close relation with the central, terminal or other trigeminal branches which supply various areas, thereby innervating the temple, teeth, forehead, etc. As a result, painful stimuli may arise within an accessory sinus, the nasal cavity, eye, teeth and ear; and the pain may be referred to and interpreted as pain at a distant point, as, for example, the temple, forehead, occipital region, or other regions than the points of stimulation.

By applying strong stimuli to the teeth or mucous membrane, such as a current of electricity, oscillations in the eye, accompanied by increased lacrimation which is due to the stimulation of the second and third divisions of the fifth nerve will be produced. When the stimulus is applied to the soft palate alone, increased lacrimation is all that is produced.

The various frequent references by the patient to painful stimuli, such as nasal, ocular, aural, or dental to the occipital region, are anatomically explained by the central contiguity of the ophthalmic, maxillary and mandibular afferent sensory terminals to those of the upper three cervical nerve roots, located in the region of the descending trigeminal nucleus. (See Figs. 44, 45 and 60.) The terminal or peripheral distribution of the three upper cervical nerves is located posteriorly to the head and neck. (See Figs. 43 and 121.) Take, for example, the nasociliary nerves, the stimulation of which may be due to an irritant, such as trauma, and may be located in the nasal region. The sensory fibers composing the nasociliary nerves, are enclosed within the first or ophthalmic division of the fifth nerve with the fibers of the frontal, supraorbital and supratrochlear nerves which supply the supraorbital and frontal region. (See Figs. 51 and 54a.) It is a well-known fact that the pathology which involves the nasociliary nerves may produce neuralgia of the forehead and scalp region by the radiation of pain transmitted along the path of the frontal, supraorbital and supratrochlear nerves with which they are closely associated.

Another striking example of referred pain is the neuralgia which manifests itself in the ear, caused by a carious tooth located in either the upper or the lower jaw. This is due to the relation of the facial nerve to the fifth or trigeminal. The pain is produced in the ear through the tympanic branch, which passes through the tympanic membrane and is associated with the auriculotemporal nerve through which the third or mandibular communicates with the external auditory meatus. (See Fig. 119.)

A frontal headache may be caused by a carious tooth, infection of the antrum, pulp nodules, alveolar abscess, eye strain, etc. To locate the etiology of referred pain, the operator must be a keen diagnostician and search for the direct cause by careful physical examination and by the process of elimination. Many nerve trunks have been blocked with alcohol to give the patient relief, the cause of the pain having been overlooked by the operator, while, if located and removed, no deep nerve block injection would have been necessary.

There is no pain quite so severe and agonizing as that of trifacial neuralgia or tic douloureux. In mild cases the patient may suffer only intermittently, sometimes going for days, weeks, or even months, without an attack, but without a moment's warning, the patient may be seized with a severe attack. In the worst types of cases, the pain may be agonizing and practically continuous, and, in most cases, associated with spasmodic facial contractions. Many of these patients have undergone every known medical treatment, with little or no success as a result.

CLASSIFICATION OF VARIOUS FORMS OF TRIGEMINAL NEURALGIA

It is extremely important to differentiate between the following forms of trigeminal neuralgia:

1. Purely peripheral, preganglionic, extracranial.
2. The ganglionic type.
3. The retroganglionic or intracranial, reflex types caused by new growths, tumors, cortical lesions, etc.
4. Symptomatic pains caused from other lesions which yield to a different treatment than that for the primary type of tic douloureux.

ETIOLOGY AND PATHOLOGY OF SYMPTOMATIC PAIN NEURALGIA

The etiology and pathology of symptomatic neuralgia are more or less obscure, for in the greater number of patients, no lesion can be found of the trigeminus nerve or the Gasserian ganglion. In the symptomatic type of neuralgia the female sex is more often affected. Most cases are found in the first half of life, and are generally manifested during the spring or winter, the left side being more often involved. The superior maxillary and mandibular divisions of the trigeminus are most susceptible to the so-called rheumatic influences, while the first or ophthalmic branch is more susceptible to malarial and septic poisonings. There is no question but that alveolar abscesses, decayed teeth, sinus infection, pulp stones, abnormal roots, impacted or unerupted teeth, malformed teeth, necrosed bone, etc., have played an important role in producing the symptomatic type of neuralgia, predisposing to tic douloureux. Ocular, nasal, antral, and frontal sinus disease may be the cause of neuralgia in the supraorbital nerve. Hysteria, malaria, epilepsy, syphilis, focal infection, trauma, neuritis, herpes zoster, chronic tonsillitis and tumors may be important factors in causing excruciating trigeminal pains. A carious tooth, alveolar abscess, tumors, or empyema of the antrum are very frequent factors in the causation of trifacial neuralgia of the second division; whereas an impacted lower third molar is an important cause of mandibular neuralgia.

Symptoms of Neuralgia. - The symptoms classified as symptomatic are pains that are sharp and intense, with exacerbations and remissions. Their character and duration depend upon the etiology; various causes producing different symptomatic pains. Other symptoms present are discussed under the "Symptoms of Tic Douloureux."

Etiology and Pathology of Tic Douloureux.—Tic douloureux is a special form of trifacial neuralgia which occurs in middle or advanced life, and is usually very severe in its symptoms and obstinate in its course. It should always be distinguished from the ordinary or symptomatic form of trifacial neuralgia. Tic douloureux is a special disorder and in most cases is dependent upon changes in the nerve itself. It is one essential primary type which dominates the clinical picture of trigeminal neuralgia. The peripheral or extracranial reflex and the central or retro-ganglionic types of trigeminal neuralgias may be caused by some form of intracranial or cortical pathology, such as tumors, gumma, etc. The various forms of psychoneuroses which so often attack the fifth cranial nerve, are purely symptomatic and are only secondary manifestations of other pathological conditions. These conditions will in most cases yield to treatment other than that which is necessary to arrest or remove the cause of the essential and primary pathology of the nerve trunk, which is recognized as tic douloureux.

Tic douloureux is no doubt due to either a toxic or to an atrophic process which exists at some point in the various nerve branches, Gasserian ganglion, or brain. A low grade neuritis which may be caused by infection, such as an alveolar abscess, empyema of the antrum, or impacted third molar with infection, as a rule, does not show changes in the nerve branch, but the small arteries which supply the nerves are bound to undergo an endarteritis which causes their caliber to decrease and prevents the nerve from receiving its proper nourishment. In some cases the Gasserian ganglion has shown degenerative changes, but these have been considered purely secondary. In these cases the operation for the incision or removal of the nerve trunk itself eliminates the pain. Therefore these degenerative changes have not as yet proved a causative factor of tic douloureux.

In some cases neurotic changes have been found, such as an increase in connective tissue or increased vascularity, but even the cause of this pathological change has not yet been determined although it may be considered the result of former treatment, such as the injection of alcohol into the nerve branch which has produced the neurotic changes. There may be impingement upon the nerve trunk by a tumor, exostosis or cicatricial tissue.

Within recent years, it has been found that in some of the cases where the Gasserian ganglion has been removed, a definite bony protuberance situated on the superior aspect of the anterior surface of the apex of the petrous portion of the temporal bone and anterior to the Gasserian ganglion, extended into the substance of the Gasserian ganglion. Without doubt, this extension of bone is an exostosis and a possible causative factor in the production of the symptoms of tic douloureux. Those patients in whom the exostosis and the impinged ganglion was found, experienced pain in all three branches of the fifth nerve.

Syphilis, causing the formation of a gumma, extreme exposure, infection and other depressing influences are many times the etiological factors, together with pathological conditions existing in the orbit, empyema of the antrum, frontal sinus involvement, and other local diseases as described under the heading of "Etiology and Pathology of Symptomatic Pain Neuralgia."

Symptoms of Tic Douloureux.—The symptoms of tic douloureux are characterized by severe, agonizing, shooting pains, which in most cases begin in the region of the nose, jaws, or upper and lower lips, and from this location radiate through the teeth into the orbital cavity, or over the temple, brow and forehead. During a severe paroxysm, the patient's face is highly flushed, usually pinched and drawn. Increased lacrimation, running from the nose, spasmodic contraction of the facial muscles and tongue may occur, with the patient groaning and manifesting an expression of extreme agony. Often the patient experiences only a single attack lasting from one to several minutes. Returning attacks are, however, not unusual, and if this is the case, each additional one may be less intense than the one previous to it. The paroxysms of pain in tic douloureux may be started by the patient in speaking, eating, moving the tongue, the touch of the finger to the face, taking of liquids or food in the mouth, swallowing or taking of sweet or sour things, the slamming of a door, a draft of air, or the inhaling of cold air. In taking food or drink, the paroxysm is more likely to be brought on if the substance taken is either sweet or sour, but the fact that the food or drink is either hot or cold is not a factor in bringing on the paroxysm; therefore the beginner need not confuse tic douloureux with pulpitis. A delicate touch such as the weight of a fly will bring on a paroxysm more quickly than will a heavy pressure such as the slap of the hand. In fact, the patient, upon the approach of a paroxysm, will suddenly slap his hand heavily over the affected part and begin a vigorous massage, all the while smacking the lips and drawing the mouth toward the opposite side. This is a typical clinical picture especially when the pain is at the mental foramen.

The patient experiences more difficulty and pain during the fall and winter months and in some cases may entirely escape an attack during the summer months.

The pains during the attacks are always located on one side of the face and in most cases are centered in one branch of the fifth cranial nerve, the second or maxillary division being more often involved, the next being the third or mandibular division. However, it must be remembered that the pain may not remain in the region of these two branches, but may spread to the whole side of the face. In addition to the symptoms described, there are often associated with the pain spasmodic contractions of the facial muscles and tongue or the lower jaw presents quick movement. The patient may be awakened and spend many sleepless hours; there is also impairment of nutrition. In some cases the patient may not eat for fear of starting another attack. Depression of spirits is present in many cases, for the pain the patient suffers is one of intense agony; no doubt the worst pain nature could devise.

The writer has never seen a patient with true bilateral facial neuralgia, and it is his opinion that those patients who complain of feeling pain on both sides are not suffering from true bilateral tic douloureux.

The cause of neuritis is usually a general systemic one. It may be from a bilateral local lesion of the teeth or of the several sinuses and it must not be forgotten that impairment of vision may also be an important factor in causing complaint of bilateral pain.

The clinical picture in various individuals differs considerably. Some patients will not talk, eat or drink, and if they do, they may attempt to confine the food to one side of the mouth, all of which is done in an attempt to ward off an attack. Some patients will not wash one side of their face or brush their teeth on one side, for they are always in constant fear of causing a severe paroxysm of pain. In most cases the pain begins in one definite spot and radiates in various directions, involving only the side of the starting point. When the pain subsides, it usually returns in the same spot where it previously began and radiates in certain directions, although the patient describes it as in one certain location, which can in most cases be covered with a ten cent piece. Later on, several pain centers may develop and pain begin simultaneously in all of them, or may take turns, radiating from one to another. The pain may be situated over the nerve branch in which it first appears, later involving a number of branches. Patients who have suffered for years with this condition become somewhat accustomed to the painful attacks. However, they show great evidence of extreme pain during the paroxysm but learn to control their outcry.

Diagnosis.—In the diagnosis and treatment of patients suffering from tic douloureux, a thorough and careful examination should be made, and all modern methods of diagnosis utilized. *First*, one should ascertain the exact condition; *second*, determine whether the condition is trifacial neuralgia or not. If such is the case, then palliative or expectant treatment is given with the object of improving or permanently eradicating the cause. This happy result, which is always appreciated by the patient, can be accomplished in some who are suffering from tic douloureux. A Wassermann test should always be made in order to find or rule out syphilis.

One of the most important diagnostic aids in determining the etiology of this condition is roentgenograms of the teeth and osseous structures, antrum and sinuses, more particularly the frontal sinus. The x-ray plate should disclose the presence of pulp stones, abnormal roots, malformed teeth, unerupted or impacted teeth, supernumerary teeth, necrosed bone, empyema of the antrum, etc. In connection with the x-ray plate showing the frontal and maxillary sinuses, transillumination is of value. The time element is one of the strongest points in diagnosing tic douloureux, the more recent cases requiring careful differentiation and study.

DIFFERENTIAL DIAGNOSIS

A differential diagnosis must be made from pain caused by pulpitis, pus infection, impacted or carious teeth, or from a malignant growth. If the operator takes a careful history of the case and is very observing, he will note that the pain arising from these factors is different from pain caused by a true case of tic douloureux. If the pain is paroxysmal in character, attacking the patient suddenly in one or more circumscribed areas, situated over some sensory nerve branch or branches and persistently returns in a few hours, days or months at the same area and does not yield to medicinal treatment, it is undoubtedly a case of tic douloureux. In making a diagnosis, one should remember that a hysterical facial pain is frequently mistaken for tic douloureux. In cases where a mistake in diagnosis has been made, a nerve resection or alcoholic injection has proved of no benefit to the patient.

TREATMENT

The treatment of trifacial neuralgia is of great importance to the medical and dental professions. Its treatment is four-fold in character and is as follows:

1. Medicinal or palliative.
2. Neurectomy and neurectasis.
3. Block anesthesia.
4. Removal of the Gasserian ganglion or its sensory root.

MEDICINAL OR PALLIATIVE TREATMENT

It is always well to resort, first, to medicinal treatment, for it will assist in verifying the diagnosis. It is well to remember that some patients suffer only intermittently in the beginning and that this initial mild attack may last for months or even two or three years. Some local medicinal remedies have been employed in the treatment and have been unreservedly eulogized because of the cessation of pain following their application, which was no doubt in many cases merely a coincidence. If a positive Wassermann is obtained and syphilis is diagnosed, then by all means, rigid treatment for syphilis must be given.

A large number of therapeutic and palliative drugs have been administered to allay the pain of this very harmful and distressing malady. There is no specific drug treatment for the cure of facial neuralgia. Some of the drugs which have been used with a variable degree of success, are as follows:

Nitroglycerin, given in doses of 1/200 of a grain, every two hours. Aconitia in doses of 1/200 grain until its physiological effect is obtained.

Codein, gelsemium, and quinin are administered in various doses. Tonics, containing such drugs as phosphorus, iron, arsenic, strychnin, and quinin are also employed. Many patients suffering from tic douloureux develop the morphin or opium habit, and a physician or dentist should be very careful in prescribing such a drug, because of the possibility of starting the patient to form the drug habit.

The wholesale extraction of teeth has been resorted to by some operators, only to find that in many cases after the teeth have been removed, the patient has sacrificed a good set of teeth, with no relief. The operator, therefore, should be very careful to eliminate other possible causative factors before he resorts to the forceps. A careful examination of all the teeth through the medium of the x-ray should disclose such pathological conditions as pulp stones, supernumerary teeth, unerupted or malformed teeth, alveolar abscess, necrosed bone, and antrum involvement. If a careful examination by the x-ray does not reveal some pathological condition which indicates the removal of the teeth, then by no means should the patient's mouth be mutilated at random by wholesale extraction of teeth.

It is always well to give the patient suffering from this condition a thorough course of systemic treatment before resorting to surgery. Systemic treatment not only includes the various drugs previously mentioned, but also comprises diet, rest in bed, local application of heat or cold, massage, and other measures which will benefit the patient. By treating the patient in this manner, surely no harm will be done, and if it fails, there is plenty of time to utilize other forms of treatment. Medicinal or palliative treatment should extend over a period of time sufficient to convince the physician or dentist that it is useless to continue.

As a palliative measure, the following prescriptions will be found of value:

℞	Camphoras Gumma	
	Chloralis Hydratis	āā ʒ iv
	Alcohol	q. s. ℥ ss

Misce. Sol—

Sig.: Apply externally over painful area.

℞	Tincturae aconiti	ʒ iiss
	Oleum gaultheriae	℥ i
	Linimentum Chloroformi	q.s. ad. ℥ iv

Misce.

Sig.: Apply externally over painful area.

℞	Menthol	ʒ ss
	Oil gaultheriæ	ʒ ii
	Oil eucalyptol	ʒ ii
	Lanolin q.s. ad.	ʒ ii

Misce.

Sig.: Apply over painful surface several times daily.

℞	Chloroformis	ʒ i
	Alcoholis	ʒ i
	Tincturae aconiti	ʒ ii
	Olei menth. pip.	ʒ iii

Misce.

Sig.: Apply externally over the painful surface.

Dr. Matas is quoted as follows from his paper read before the National Dental Association, October, 1919:

"The *treatment* of facial neuralgia in the distribution of the trigeminus has engaged the attention of physicians and surgeons from time immemorial. A vast therapeutic and pharmacological arsenal has been brought into play for the relief of this most painful and distressing affection. While there is no specific drug treatment for the cure of the confirmed type of facial neuralgia, a knowledge of the resources of pharmacological therapeutics is indispensable for the symptomatic relief of pain. Innumerable and most ingenious methods of neurectasis (nerve stretching) and neurectomy have been devised for the cure of this condition; some of these are still of value for the relief and possible cure of the peripheral forms in certain classes of subjects who are physically unfit to undergo any serious trauma. In practice, at the present time, the treatment of the essential and confirmed disease of the trigeminus is limited to a choice of: (a) the alcoholization of the nerve trunks at their origin from the basal foramina, (b) alcoholization of the Gasserian ganglion, (c) Gasserectomy or (d) intracranial division or avulsion of the sensory root of the fifth nerve as it enters the ganglion. The ideal treatment in all forms of neuralgia would be to obtain a cure of the neuralgia, or pain, without leaving behind a permanent anesthesia of the region tributary to the affected nerve, or causing secondary trophic lesions of a neuro-paralytic character such as follows in the anesthetized eye, after destruction of the ganglion either by alcohol or operation. The cure of the neuralgia without consecutive anesthesia, desirable as it is,—is thus far unattainable for the ganglionic cases,—but the trophic lesion, so much dreaded in the eye, which follow extirpation or alcoholization of the ganglion can be largely avoided by the proper selection of the surgical method of treatment adopted."

TREATMENT BY NEURECTOMY AND NEURECTASIS

There are many ingenious methods for performing neurectasis (nerve stretching) and various methods of neurectomy are used in the treatment of this condition. Some of these methods are of great value for the relief and cure of the peripheral types, which in many cases cannot undergo any serious surgical procedure.

The nerve branches that are most commonly removed are the infraorbital, supraorbital, nasal and inferior dental; followed by a plugging of the foramen with ivory or some noncorrodible metal.

BLOCK ANESTHESIA IN THE TREATMENT OF TIC DOULOUREUX

At the present day, the treatment of the essential type of involvement of the fifth nerve is limited to the choice of:

1. Blocking the nerve trunks as they emerge from their respective foramina with alcohol.
2. Blocking the Gasserian ganglion with alcohol.
3. Gasserectomy.
4. Intracranial avulsion or severance of the sensory root of the fifth nerve posterior to the Gasserian ganglion. (Technic of Frazier.)

The ideal treatment is to effect a cure of the condition without producing a permanent anesthesia by alcohol, or secondary trophic lesions of a neuroparalytic character, which many times follow in the anesthetized eye, which also may be produced by operative measures, such as Gasserectomy or avulsion of the sensory root. It is impossible to inject the Gasserian ganglion with alcohol without having anesthesia follow. In many cases the trophic lesion, such as occurs in the eye following the blocking of the ganglion by alcohol, Gasserectomy or sensory root avulsion, can be avoided by careful selection of treatment.

Block anesthesia in the treatment of tic douloureux has been practiced since 1903, the first method of injecting a nerve trunk with alcohol being introduced by Schlosser. He discovered by chance that subcutaneous injections of alcohol in and about an offending nerve, produced a burning pain during and following the injection, this being replaced in a few minutes by paresthesia, numbness and anesthesia. This disappeared in a week or ten days and the tactile sensation returned; however, the pain impulses were blocked and entirely absent. Schlosser reported his findings to the profession in 1903, and at the same time Matas described the alcoholic injection. Since that time many important things have been discovered by others, and the technic has been elaborated and perfected. Many other names connected with this important link in the way of research and technic are: Oswald, Sigard, Levy, Tappas, Harris, Patrick, Offerhaus, Härtel, Martin, Allen and others.

In many cases gratifying results have been obtained by alcoholization in the treatment of tic douloureux. However, some cases will yield to this treatment only for a short time, and then the patient must undergo the surgical removal of a nerve branch, the Gasserian ganglion, or its sensory roots.

If medicinal or palliative treatment should fail, the next step in the treatment is to block the individual branches of the Gasserian ganglion. If internal medication, massage, radiotherapy and electrotherapy have all been utilized and failed, it is far preferable to employ block anesthesia prior to the extirpation of a nerve branch, the removal of the sensory root, or the Gasserian ganglion. The nerve trunk or Gasserian ganglion which is involved is blocked, and the injection of the solution will prevent the sensory nerves from conducting painful afferent sensations. If the cause of the trouble is located centrally, the blocking of the peripheral branches will not suffice. However, a number of cases have their etiology in the peripheral or terminal nerves and the injection of these nerves will give the patient relief. If the nerve branch involved can not be definitely located, it is much better to block the deeper branches, such as the second or third division, or the Gasserian ganglion. In other words, the closer to the brain the solution is injected, the more possible the successful outcome.

The blocking of the terminal or peripheral branches is more simple, but it is not as efficient in most cases as the blocking of the deep branches. The deep block injection should be utilized prior to nerve resection, since a deep injection causes less debility and discomfort to the patient and is much preferred. The results which follow the injection of a nerve trunk are in many cases highly gratifying, the duration varying with different individuals.

The writer has made many block injections in the treatment of tic douloureux with varying degrees of success. In some individuals the pain returned within four months, while in others, blocked over five years ago, the symptoms have not returned. Most operators state that the patient will get relief, in the average case, in from one to two years, and when the symptoms return, the injection is made a second time. Undoubtedly, all will agree that it is preferable to repeat the injection, when necessary, if patients are given relief, than it is to remove the Gasserian ganglion or its sensory root. In 1840 Ryud injected morphin and creosote for the treatment of tic douloureux. A large number of drugs have been employed, such as chloroform, ether, osmic acid, chromates, formaldehyde solution in glycerin, phenol, menthol, antipyrin, salicylates, quinin salts, all of which have been abandoned in favor of the alcoholic combinations and surgical treatment.

The Alcoholic Injection.—Alcohol in strength from 70 to 90 per cent is given with or without the addition of other ingredients. Some operators add a small amount of a local anesthetic to the alcohol before injecting. The author does not advise this, because alcohol causes great pain before the local anesthetic has had time to produce anesthesia of the part. He advises that the nerve trunk be blocked by injection of procain suprarenin Ringer solution, allowing ample time for deep anesthesia to occur before making the alcoholic injection. By blocking the nerve with a separate injection the excruciating pain which the patient experiences following the injection of alcohol will be eliminated. Alcohol in contact with nerve tissue produces a burning sensation which is followed by numbness and anesthesia. *The injection of alcohol, without the part being previously anesthetized by a local anesthetic, should not be practiced, for the patient's feelings should always be considered.*

It is not always necessary to remove the needle after the local anesthetic solution has been injected for deep injections, as it can easily be separated from the tip of the syringe left in position, and in a few minutes the hypodermic syringe is filled with the alcoholic solution, the hub of the needle placed over the tip of the syringe, and the solution slowly injected. It is better in most cases to remove the needle, if the block injection is being made by the intraoral method, but if the Gasserian ganglion, second or third divisions are being blocked by the extraoral method, it is far better to leave the needle in position.

The alcohol should not be injected immediately following the injection of the local anesthetic solution for two reasons:

1. Sufficient time must elapse for anesthesia to take place.
2. To allow the procain suprarenin Ringer solution to diffuse through the tissues so as not to dilute the alcohol when injected.

It is much better to inject a 95 per cent solution of ethyl alcohol than a weaker solution, because it is injected into tissue which has been previously injected with a local anesthetic, and, even after waiting several minutes for diffusion and anesthesia, there yet remains a sufficient quantity of the solution in the tissue to reduce the percentage of alcohol injected. If the part has been blocked by a local anesthetic, no discomfort will be experienced by the patient when the alcohol is injected. If the part is not completely blocked when a few minims of alcohol are injected, the patient will experience paresthesia or a burning sensation lasting for a few seconds and then disappearing. If the patient should experience pain or a burning sensation following the injection of 4 or 5 minims of alcohol at intervals into an area which has not been completely blocked by the local anesthetic, no more alcohol should be injected until the sensation has disappeared.

No operator should be guilty of injecting alcohol into any ganglion or nerve trunk without first blocking the part with a local anesthetic and allowing ample time for the drug to take effect, or placing the patient under a general anesthetic. The operator should test the area of anesthesia which has been produced by the procain suprarenin Ringer solution, if block anesthesia has been employed, prior to injecting the alcohol.

Solution Containing Several Ingredients.—Some operators prefer a solution which contains ingredients in addition to the alcohol. The formula proposed by Patrick, and modified by Blair, is as follows:

℞

Procain	2 per cent
Chloroform	5 per cent
Alcohol	70 per cent
Water	23 per cent

Misce.

If the above formula is employed, the amount injected is from two to three mils, and in case the injection is in the orbit the quantity of chloroform should be reduced to 2 per cent. The amount injected, however, depends upon the diameter of the nerve trunk injected; when the Gasserian ganglion is blocked, three mils of the solution are injected; in case the second or third division of the fifth nerve is to be blocked, two mils of the solution are injected.

The author's technic is to make a deep block injection with a procain suprarenin Ringer solution, and, after profound anesthesia has been secured, inject the required quantity of 95 per cent ethyl alcohol.

In recent years Weiner has been experimenting with the following solution.

℞

Calcium chlorid	.75
Sodium chlorid	6.
Water	1000.

Misce.

He has reported the following which is very interesting: "In the treatment of sciatica, 51 cases were cured and 8 improved, 4 yielded to treatment and are reported cured, 2 greatly improved, and two failures." If the above solution proves to be as serviceable in the hands of other operators as in those of Weiner, it may take the place of alcohol. However, this remains to be seen. It is very gratifying for the operator to be able to relieve almost instantly the patient who is suffering from intense pain caused by tic douloureux, and in many cases an apparently permanent cure is accomplished by the injection of alcohol. On the other hand, we must agree that some other solution which would produce the same results might increase the popularity of treating tic douloureux by the block method. The author is enthusiastic over the results he has obtained in treating tic douloureux by the deep block method, and in his opinion there can be no question that, if the injections are properly made, it will give nearly every patient relief which will extend over a period of from four months to several years. This is always preferable to the radical operation for the removal of the Gasserian ganglion or the severance of the sensory root. Some operators claim they do not secure efficient results following the alcoholic injection, and no doubt some of their failures can be attributed to the fact that the solution has not been deposited in contact with the affected nerve trunk.

Effect of Alcohol Block Injections on the Tissue.—Alcohol injected into nerve tissue has a destructive action, and its curative effect in the treatment of tic douloureux is due to the destruction produced when alcohol has been injected into the ganglion or nerve branches. The greater the nerve destruction, the greater the atrophic disturbance in the eye which may follow the blocking of the aged and feeble patient who suffers more often from this malady, and who is blocked with alcohol in preference to Gasserectomy or sensory root avulsion. Its action, when injected into any kind of tissue, is degenerative, but the extent to which it produces its destructive process depends on the kind of tissue injected. For example, the skin and muscle tissue are not affected to such an extent as the loose connective or nervous tissue. In other words, it produces a greater destructive effect on highly organized tissue, such as ganglia, nerve trunks, brain tissue, etc. The pathological process which takes place following an alcohol injection is that of aseptic necrosis, and the loss of tissue by necrosis is in time filled in with fibrous connective tissue. It is, therefore, very important to use every measure of aseptic precaution while making a deep block injection, for if the destructive process which is in the form of necrosis, should become infected, a serious outcome might be encountered. If an alcoholic solution is injected into or beneath the skin, it produces a painful burning sensation, and if injected in sufficient quantity it may produce sloughing. The operator should never inject more alcohol than is absolutely necessary to produce the desired result.

Another precaution the operator should always take is to inject the solution very slowly and have the point of the needle covered with nerve tissue. The injection of the solution into the tissue near the nerve trunk or ganglia may result in failure, because a sufficient quantity of alcohol may not penetrate the ganglion or nerve trunk. The destruction of tissues which occurs is in the form of aseptic necrosis, which causes a break in the nerve fibers and nerve cells destroyed and which are replaced by fibrous connective tissue over which the painful afferent impulses can not pass. The successful outcome of a deep nerve block injection with alcohol depends on several factors, among which are:

1. The quantity and percentage of alcohol injected.
2. The injection of the solution directly into the substance of the ganglion or nerve trunk.
3. The amount of nerve destruction caused by the alcohol and the amount of connective tissue which has formed following the injection as the result of the original tissue necrosis.
4. If the injection has been improperly given, only a small amount of nerve destruction takes place, which results in the formation of a small amount of fibrous connective tissue, which, in turn, results in a rapid regeneration of the nerve trunk, possibly within a few months, with a return of the symptoms of tic douloureux.

It is true, if the symptoms return, the injection can be repeated as often as necessary. However, if the nerve trunk or Gasserian ganglion has been properly injected, the patient, in most instances, will experience relief for months, years, or even permanently. Allen, of New Orleans, states that it takes at least nine months for the process of regeneration to take place following an injection.

The practice of asepsis must be scrupulously enforced, and no injection should be made unless great surgical asepsis is employed. Following an injection of alcohol, especially if it is superficial, the patient will feel a slight amount of soreness, the tissue may become reddened and slightly indurated, which will remain present for a few days following the injection. Dr. Matas says that "*the alcoholization of the ganglion is a surgical procedure which requires experience, judgment, and knowledge of technic, quite equal to that of the surgical extirpation of the ganglion.*"

Preparation of the Patient for Injection.—The technic for deep injections of alcohol should be strictly surgical with the patient in a semisupine or horizontal position. Before making a deep injection it is good practice if the patient is nervous to give him a hypodermic consisting of $\frac{1}{6}$ to $\frac{1}{4}$ grain of morphin and $\frac{1}{150}$ grain of scopolamin. This preliminary hypodermic should be given at least three hours before the operation, while in extreme cases it should be repeated before the deep injection is made. If the injection is by the extraoral route, the skin is thoroughly prepared by scrubbing, followed by the application of benzin or tincture of iodin, then alcohol. Next make a preliminary injection into the skin with a very fine, sharp needle, at a point where the deep block needle is to be inserted. One mil of procain suprarenin Ringer solution should be slowly injected into the skin and subcutaneous tissue. This preliminary injection should produce a wheal at least 2 cm. in diameter. Following this a procain suprarenin Ringer solution is injected to anesthetize the nerve tissue prior to injecting the alcohol. If these measures are not employed, the blocking of the Gasserian ganglion is a very painful operation. The preliminary hypodermic of morphin and scopolamin is of great value, as well as the preliminary local anesthetic injection, and both of these should be employed prior to the extraoral deep block injections of the Gasserian ganglion, second or third divisions.

Needles Employed.—The same needles are employed for injecting alcohol as are used for blocking the nerve trunks with a local anesthetic, all of which are described elsewhere in this text. Therefore, the needles employed depend upon the nerve trunk that is being blocked and the method used. If by the intraoral method, then needles, such as Nos. 2, 4, 5, and 6 are used; if by the extraoral route, needles Nos. 4, 7, and 8 are used. Needle No. 7 is for the preliminary injection into the skin. Needle No. 4 is for the extraoral infraorbital injection. Needle No. 8 is for blocking the second and third divisions of the fifth nerve by the extraoral route. (See Fig. 177.) For blocking the Gasserian ganglion, a triangle and two needles are employed; one 18 gauge, 100 mm. long and equipped with a stylet; the other 60 mm. long, graduated in centimeters, and having no lumen. (See Figs. 548 and 549.)

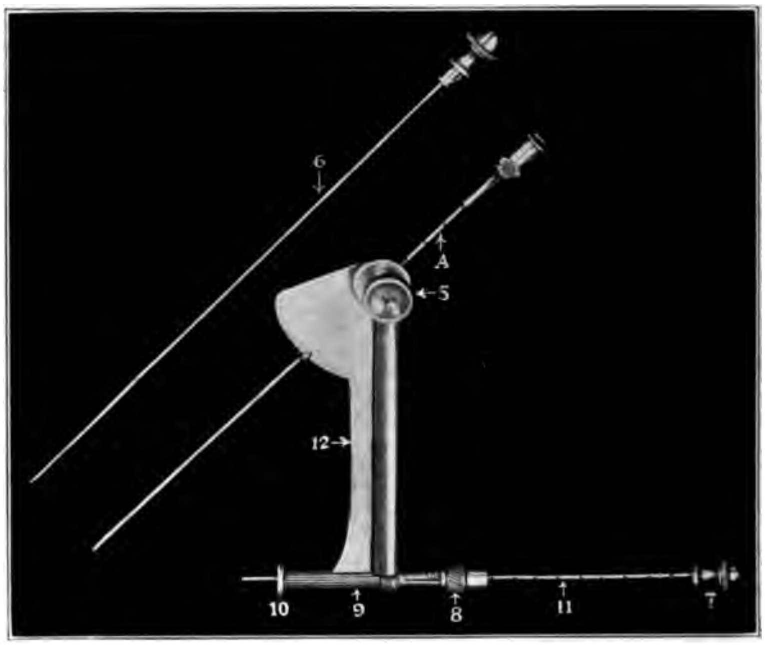


Fig. 548.—Triangle for blocking Gasserian ganglion.

A, Graduated needle; 5, nut for holding guide; 6, stylet for needle, A; 7, thumb piece on solid needle; 8, nut for locking needle 11; 9, guide for needle 11; 10, part which rests upon surface of skin; 11, solid graduated needle; 12, perpendicular of triangle.

Indications for Blocking the Gasserian Ganglion.—The indications for blocking the Gasserian ganglion are those cases of severe trifacial neuralgia, for which the cause can not be discovered, or, if discovered, can not be removed by medicinal or palliative treatment. There are really no serious contraindications; however, care should be used with a patient having such pathological conditions as a marked heart lesion, kidney involvement, or high blood pressure, etc. While these lesions increase the seriousness of the situation, they are really not contraindications, provided the injections are skillfully made. It is self-evident the patient must be given relief, and the deep block injections should be tried before subjecting the patient to a Gasserectomy or severance of the sensory root.

Technic of Blocking the Gasserian Ganglion.—The blocking of the Gasserian ganglion is strictly a surgical procedure which requires experience, judgment, and a knowledge of the technic and anatomy of the parts. No operator should ever attempt to block the Gasserian ganglion or any of the deep nerve trunks unless he is absolutely sure of his technic and is thoroughly familiar with the anatomy. If he is unfamiliar with all details, results will not be obtained, and the patient is likely to be the victim of experimentation. These injections in most cases afford relief and can be repeated when necessary.

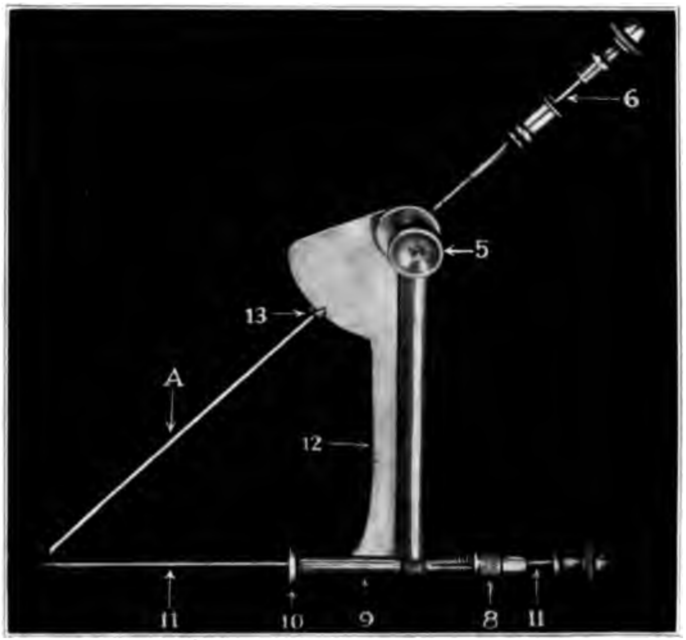


Fig. 549. Triangle for blocking Gasserian ganglion.

A, Graduated needle through which solution is injected; 5, lock nut for holding guide, 13; 6, stylet; 8, lock nut for holding solid needle 11; 9, guide; 10, flattened portion of guide which rests upon skin over external articular tubercle; 11, solid needle which is graduated; 12, perpendicular of triangle; 13, guide.

The first method for blocking the Gasserian ganglion was introduced by Schlosser, as has been stated, but since its introduction numerous methods have been worked out for reaching this ganglion. The writer does not think it necessary to include all the different methods in this text, but will discuss briefly the most important ones.

The Harris Method for Blocking the Gasserian Ganglion.—Dr. Wilfred Harris, of London, was among the first to report a technic of direct injection of the Gasserian ganglion. He draws a line with a dermographic pencil from the inferior border of the ala of the nostril to the incisura notch located above the lobule of the ear. The next step in the technic is to locate the tubercle, which is situated at the base of the zygoma, at a point approximately 2½ cm. anterior to the middle of the external auditory meatus. A vertical line is now drawn through the tubercle at right angles to the zygoma. If this line is carried through the skull, it would represent a plane which would pass directly through the foramen ovale at a depth of 4½ to 6 cm. from the external surface. This distance, however, is dependent upon the shape and size of the skull. The needle enters the skin 1 cm. anterior to the vertical line and on a level with the line drawn from the ala of the nose to the incisura. The needle is directed slightly upward and backward, holding it at such an angle that when inserted the proper depth it will enter the foramen ovale. There is some danger of injuring the internal maxillary artery in this route, but good technic and accuracy will reduce the risk. This method is considered by many operators more easily executed than the Härtel and Offerhaus methods. There is less danger of injuring the internal maxillary artery by the two latter methods than by the former. However, the injury of this artery is rare and is a minor factor when the proper technic and needle are employed. *The danger in this procedure is a negligible factor, while the needle point is outside the foramen ovale, but when it has passed through the foramen into the skull, if the needle is forced in too far, there is some probability of penetrating the internal carotid or cavernous sinus situated in direct alignment with the needle.* All these methods have a disadvantage because the distance which the needle passes through the foramen ovale is not known. The distance should not exceed 15 mm. The foramen ovale and rotundum are difficult to reach on account of their location, and the operator must understand his anatomy, or he will meet with many difficulties. It must also be remembered that these two foramina vary somewhat in size and shape in different individuals, which is due to the individual variation in bone. Härtel states that the distance between the superior border of the apex of the petrous portion of the temporal bone and the lower posterior portion of the foramen ovale will vary from 1.4 to 2.3 cm. He also advises that the needle be passed only a minimum distance, for, if forced too far, there is some chance of injuring the posterior petrosal or cisterna pontis.

HÄRTEL'S METHOD FOR BLOCKING THE GASSERIAN GANGLION

Härtel was the first to perfect a method whereby the needle traversed the cheek without entering the oral cavity. The technic advised by Schlosser, Oswald and Offerhaus up to this time was somewhat objectionable because the needle reached the ganglion through the mouth, and as a result, danger of infection was encountered. Härtel's method has been followed by many operators with success. He made an anatomical study of the relation of the Gasserian ganglion to other structures and pointed out several difficulties which might be encountered. (The reader is referred to the anatomy of the Gasserian ganglion in Chapter VII.)

The internal carotid artery and the cavernous sinus are located internal to the Gasserian ganglion. Härtel blocked the ganglion by inserting the needle through the foramen ovale, the needle approaching the foramen from an anterior inferior position. (See Figs. 550, 551, and 553.) Härtel advises that the needle enter the cheek midway between the upper second molar and the malar bone, which is approximately 3 cm. posterior to the angle of the mouth, and that the skin should be previously anesthetized by a preliminary injection. (See Fig. 554.) After it enters the cheek at this point, it is extended along a line midway between the occipital and parietal fontanelles in the midline.

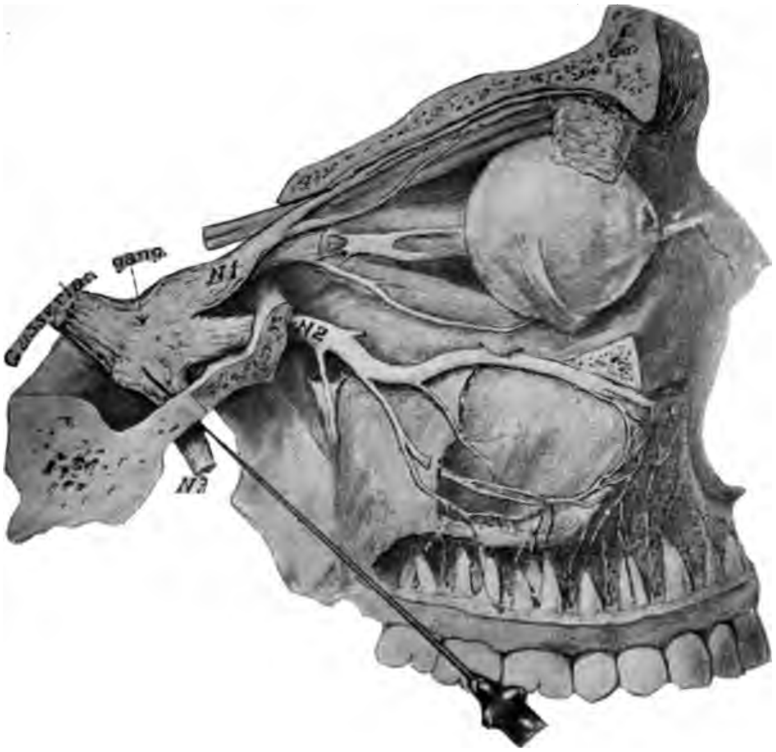


Fig. 550. - The needle is started into the tissue opposite the upper second molar and is passed through the foramen ovale. (After Hertzler.)

The needle employed for this injection is 10 cm. in length. The finger should be inserted in the mouth and used as a guide while the needle is being passed from a point 3 cm. lateral to the angle of the mouth, upward, inward and backward between the ascending ramus of the lower jaw and maxillary tuberosity. The needle should be forced in this direction until it reaches the smooth plate of the infratemporal surface which is located just anterior to the foramen ovale. The distance the needle is in the tissue from the point of puncture to the foramen ovale will vary from 5 to 7 cm. After the needle strikes the region of the foramen, it is inserted from 1 to 1.5 cm. farther, or until the patient complains of paresthesia. If the needle is carried into the tissue as previously described, it will be found that its point will come in contact with the planum infratemporale, and after it strikes this bony landmark, it is an easy procedure to force the needle upward until it reaches the foramen ovale. (See Fig. 555.) Care must be taken not to force the point of the needle beneath the periosteum, which can be avoided by elevating the end of the needle, thus forcing it along the bony plate. If the operator observes his patient from a lateral view, the needle is in a plane which bisects the articular tubercle. (See Figs. 551 and 553.)

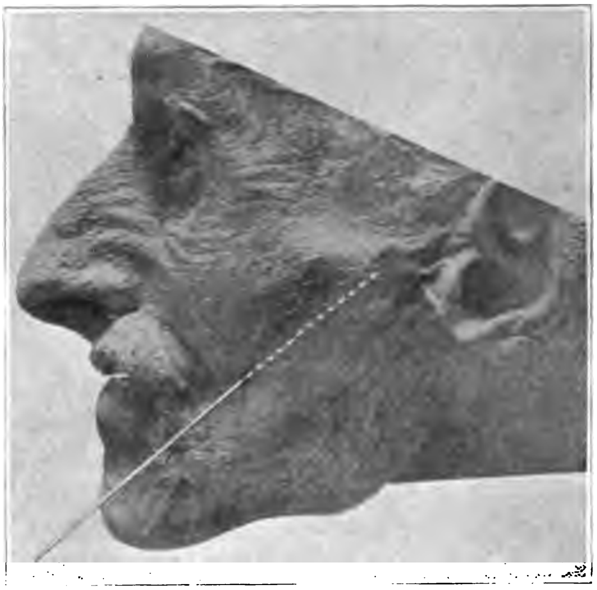


Fig. 551.—Position and direction of needle for blocking Gasserian ganglion by Hartel route. Needle is in a plane which bisects the articular tubercle. (After Braun.)

Hertzler advises a method for inserting the needle which is more accurate and simple. It is to locate the parietal eminence with the thumb and the external occipital protuberance with the second finger, while the index finger marks a point midway between the two named landmarks. With this technic, the needle enters the cheek opposite the upper second molar and is then passed directly toward the index finger which is located as described above. (See Fig. 552.) When the needle is forced in this direction, should the foramen be missed, in most cases, it will be found that the needle point occupies a position which is too far medial, and if this is the case, the needle should be retracted and inserted more laterally. If the operator understands his anatomy and follows the landmarks as outlined by Hertzler, he will find he can reach the foramen ovale with considerable accuracy.

THE FORAMEN OVALE

The position of the foramen ovale is such that it is reached with difficulty, unless the operator thoroughly understands its exact location. It is located within a very limited space in the greater wing of the sphenoid bone at the base of the skull; its location varying slightly in different individuals. (See Figs. 34, 47, and 61.) The osseous arrangement differs at times, and the operator must be on the lookout for abnormal cases. The surface osteology which surrounds the foramen ovale and all immediate landmarks should be carefully studied before attempting to make a deep injection into the Gasserian ganglion, second or third divisions. A thorough knowledge of all anatomical parts is indispensable. The necessary anatomy can not be discussed in this text, but the reader is referred to any standard text book on anatomy.

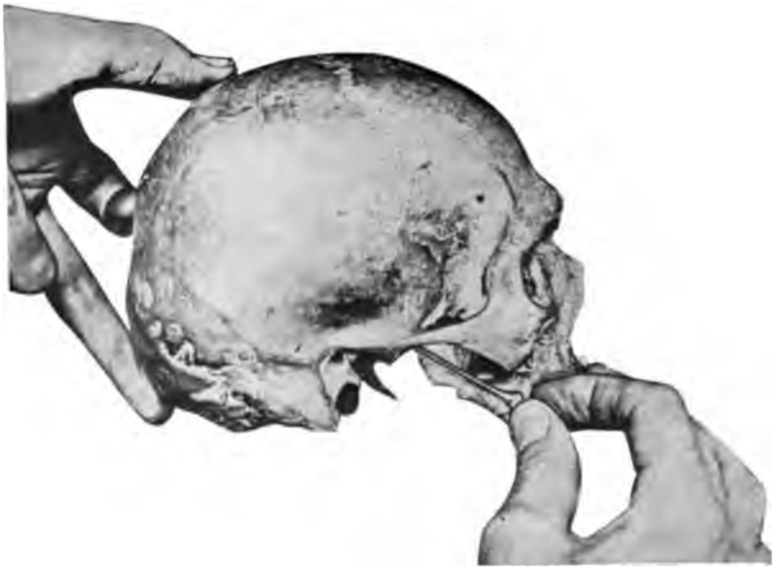
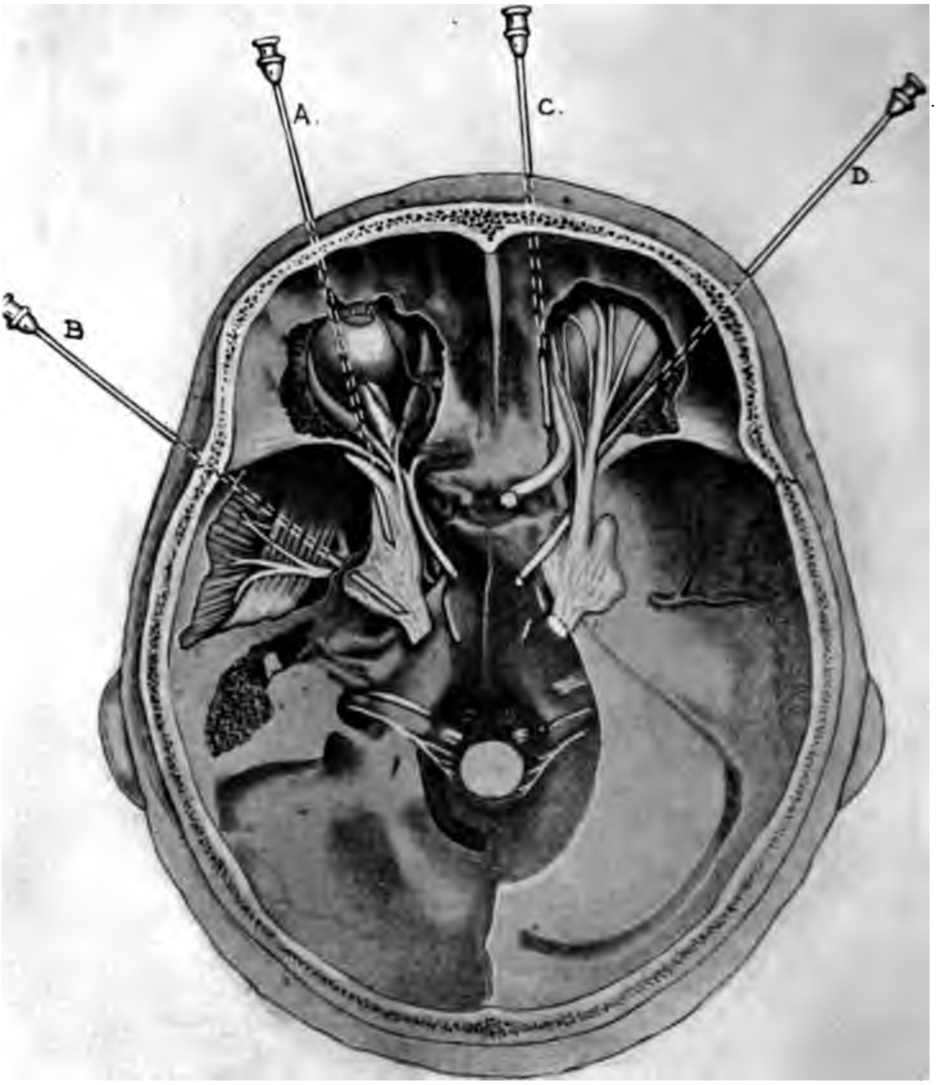


Fig. 552 The thumb marks the parietal eminence and the second finger the external occipital protuberance. The tip of the index finger lies midway between these two points. The needle entering over the second molar tooth is directed at the tip of the index finger. (After Hertzler.)

The method of approach to this foramen has been studied by numerous investigators with a view to working out a technic whereby it could be reached with considerable accuracy. Many skulls have been measured, and distances between various landmarks have been taken to determine some method or guide by which the needle could be inserted in the proper region without encountering difficulty. The routes and methods of Härtel and Offerhaus have probably been used more than any other methods, and the technic which they presented has added much to our knowledge of the subject.

Locating the Foramen Ovale.—Locating the foramen ovale has been the stumbling block encountered in the blocking of the Gasserian ganglion. Once the location of this foramen is ascertained, the remainder of the technic is comparatively easy. But, inasmuch as the foramen ovale differs in shape and size as well as location in some individuals, it is exceedingly difficult to locate it.



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Braun's Method of Locating the Foramen Ovale.—The technic for locating the foramen ovale, according to Braun, is as follows:

"The point of entrance for the needle is marked just below the middle of the zygoma, and the needle is inserted in an almost transverse direction, which is easily determined by holding a skull with the direction marked by a sound, along the side of the head of the patient. At a depth of 4 to 5 cm. the end of the needle touches the pterygoid process. In this injection the needle is about 1 cm from the foramen ovale. This distance is marked on the needle with a movable piece of cork. The needle is then withdrawn as far as the subcutaneous connective tissue and is passed back again at a slight angle to the same depth and possibly a few millimeters more. The needle is directed slightly backward and inserted ½ to 1 cm. more than the previously computed distance. Hematoma or other secondary effects never follow injections into the foramen ovale when made from without."

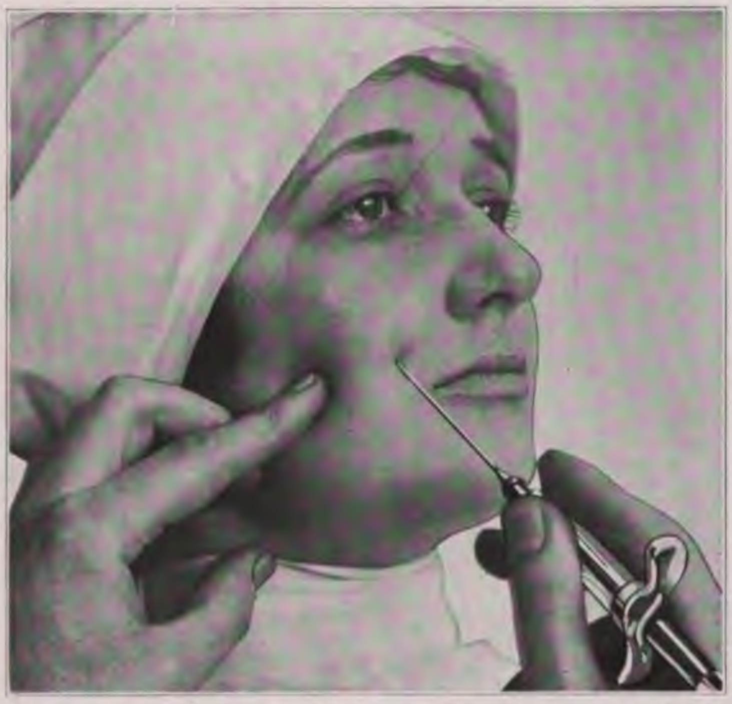

Fig. 554.—Needle entering the tissue for blocking the Gasserian ganglion by the Härtel route.

Offerhaus' Method of Locating the Foramen Ovale.—Offerhaus found the distance between the lateral aspects of the alveolar processes of the superior maxillary bone, which, when taken just behind the upper third molars, corresponded more or less to the distance between the foramen ovale represented by A-B in Fig. 556. (This measurement, however, is not accurate, but in most cases within a few millimeters, provided the arch is not constricted, which constriction would shorten the distance.) Offerhaus then subtracts the distance between the alveolar processes A-B from the length of the intertubercular line, represented by C-D, the result divided by two will give the approximate distance from the articular tubercle or eminence to A or B on same side. The reader will note that E and F, as illustrated in the photograph, represent the posterior lateral aspect of the alveolar process, on both the right and left sides.

The distance from the foramen ovale to the articular tubercle is as follows: The minimum distance is 3.6 cm., and the maximum distance 4.7 cm., while the average distance is from 3.7 to 4.3 cm. He employs an instrument to determine the length of the intertubercular line of the patient. (See Fig. 557.) This apparatus is placed upon the articular tubercle which also locates the direction of the intertubercular line through the adjustable point of the apparatus. After the articular tubercles are located, the distance between them is then measured by a sliding scale.

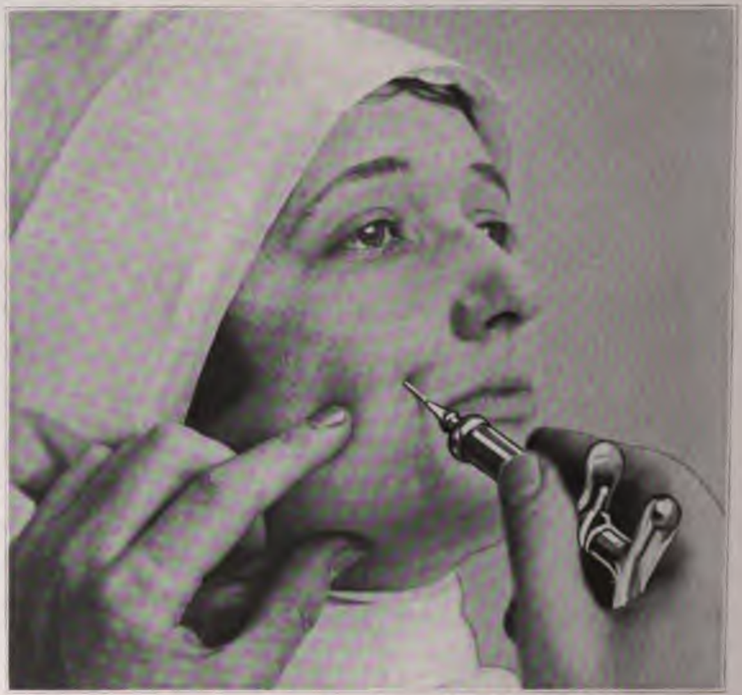

Fig. 555.—Injecting the solution into the Gasserian ganglion by the Härtel route.

The technic for inserting the needle is as follows: On the side of injection the articular tubercle is marked by a wheal, while the same point on the opposite side can be marked by a dermographic pencil. Offerhaus next advises to measure the distance between the posterior alveolar ridges of the superior maxillary bone with an ordinary compass, that is, the distance between E and F, as illustrated in Fig. 556, and then through the use of the compass, the length of the intertubercular line is ascertained. He found, after examining a number of skulls, that the intertubercular line which connects the articular tubercles, is situated just anterior to the articulation between the mandible and superior maxillary bone and also intercepts the point indicated by A-B, which is situated just below and anterior to both foramina. Therefore, the third or mandibular division of the fifth nerve, after emerging from the skull, passes inferiorly and anteriorly, and the intertubercular line passes the right and left mandibular divisions at the right and left foramina ovale.

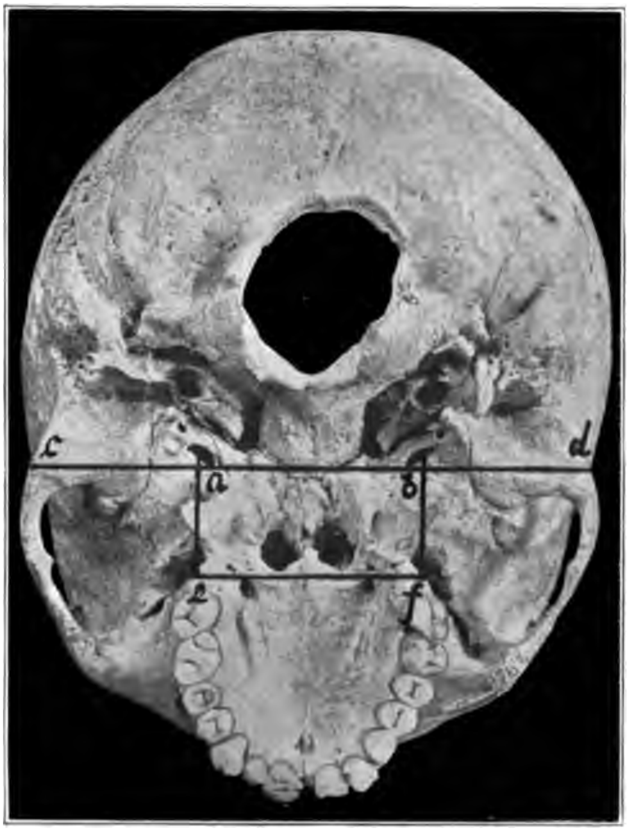

Fig. 556.—Skull measurements, according to Offerhaus, for locating the foramen ovale from the tuberculum articulare. (After Braun.)

An example of the above technic and measurements is as follows: Suppose the distance between E and F is 5 cm., and the distance between C and D is 14 cm.; then 14 − 5 = 9 ÷ 2 = 4.5 cm.; and we have the distance from the articular tubercle to the foramen ovale. After this measurement is ascertained, Braun advises placing a small piece of cork or rubber over the needle to the desired point, which indicates the depth the needle is to be inserted into the tissue. This will give the operator a definite knowledge of how far the needle has been inserted.

Smith-Neil Technic for Locating the Foramen Ovale.—Considerable time has been spent in research in an endeavor to improve and simplify the technic for locating the foramen ovale, blocking the Gasserian ganglion, and third division of the fifth nerve, and the results obtained have been highly satisfactory. Several hundred skulls have been carefully examined and cadavers dissected, taking careful measurements in order to decide on certain landmarks which could be utilized in arriving at a definite technic. It has been found that the average distance between the external articular tubercles on the right and left sides is 128 mm. in the average adult skull. An imaginary line drawn connecting these tubercles is known as the linea intertubercularis, the length of which is ascertained by the use of special calipers which is graduated in millimeters. (See Fig. 558.) The external articular tubercles are carefully located by palpation, following which the wings of the calipers are placed directly over these bony landmarks. The calipers are now carefully adjusted, making sure that the points are located directly over the articular tubercles. (See Fig. 558). With only medium pressure being exerted upon the skin, the amount is read, which indicates the length of the linea intertubercularis.

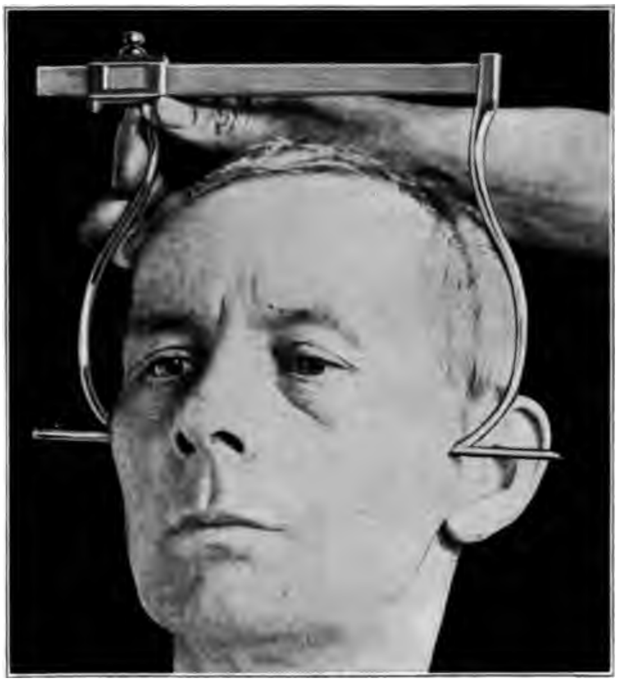

Fig. 557.—The Offerhaus calipers. (After Braun.)

After averaging a large number of cases, the distance from the external surface of the tubercle to the center of the foramen ovale was found to be 19/64 of the total distance from tubercle to tubercle. It was also found that the average thickness of the tissues, which are skin, subcutaneous and muscle tissues, external to the tubercle, was 5 mm., which is ascertained by anesthetizing the soft parts, then inserting a small needle at right angles, advancing it through the tissues until the point reaches the external surface of the tubercle. (For tubercle see number 11 in Fig. 36 and A in Fig. 563.) As previously stated, the average distance is 5 mm., making a total of 10 mm. for the right and left sides. Therefore, the soft tissue measurement, which is 10 mm., must be subtracted from the total distance of the linea intertubercularis, which was ascertained by the calipers. The following example will be used to point out the simplicity of the technic. The average measurements are given:

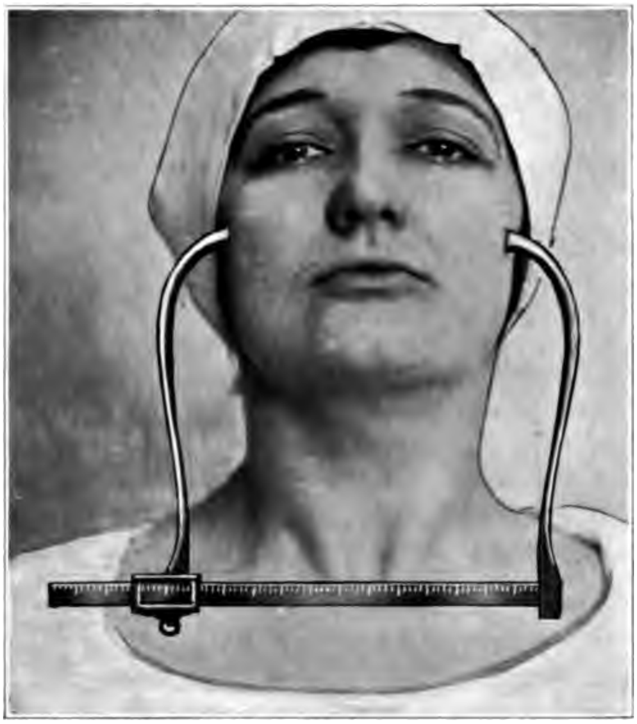

Fig. 558.—Author's graduated calipers in position over the external articular tubercles on right and left sides.

The distance from skin surface to skin surface over the external articular tubercles is found to be 138 mm., and the thickness of skin and subcutaneous tissues located over the tubercle is 5 mm. on one side, making a total of 10 mm. for both sides. Now deduct the soft tissue measurements, which are 10 mm. from the total distance of the linea intertubercularis which is 138 mm., the result will be 128 mm., which will represent the distance between the outer portion of the external tubercles of the right and left sides. Take 19/64 of 128, and the result will be 38 mm., which will represent the distance from the external surface of the tubercle to the center of the foramen ovale.

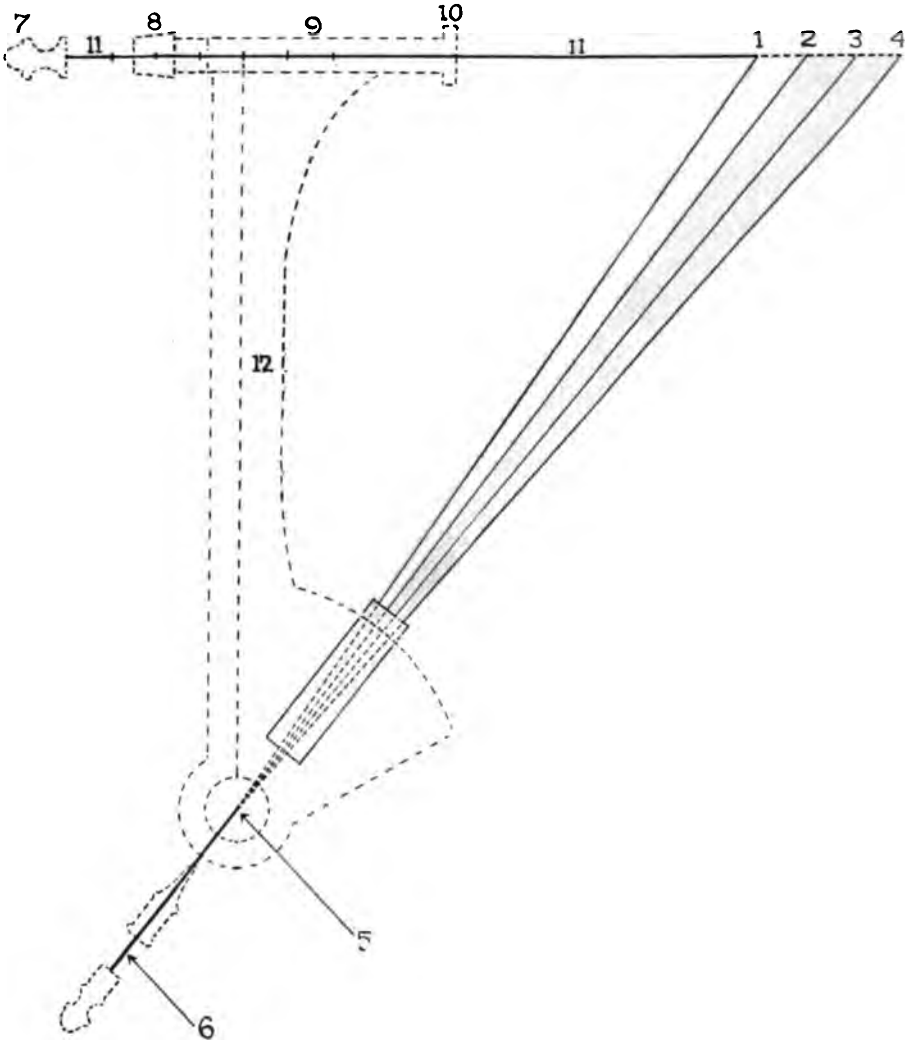

Fig. 559.- Diagrammatic drawing illustrating the principle of the triangle employed in blocking Gasserian ganglion.

1, 2, 3 and 4 represent various depths from skin surface situated over external articular tuber at which depths the foramen ovale may be located. 5 to 1; 5 to 2; 5 to 3; 5 to 4; are the various pothenuses necessary to complete the triangles with the bases 9 to 1; 9 to 2; 9 to 3; 9 to 4.

6, stylet and needle. (needle has 5 mm graduations.) 7, thumb piece on solid needle; 8, lock n 9, guide for solid needle; 10, flattened portion of guide which rests on skin; 11, solid needle, which 5 mm. graduations; 12, perpendicular of triangle.

Formula:

138 − 10 = 128
19/64 of 128 = 38
38 + 5 = 43 mm. from skin surface

The 5 mm. added represent the thickness of the soft tissues over the tubercle on one side, and the 43 mm. represent the distance from skin surface (represented in Fig. 559 by No. 10) to the foramen and is the depth of the solid needle No. 11. The location of the foramen ovale is indicated by numbers 1, 2, 3, and 4. Solid needle No. 4 must be set in order to fix the angle of needle No. 6.

The following hypothetical case worked out by proportion is self-explanatory. Example: The distance from skin to skin over the tubercles is found to be 144 mm. and the soft parts measure 6 mm. on either side which makes 12 mm. and is deducted from 144 mm. leaving 132 mm. from tubercle to tubercle.

Formula:

132 : 128 : : X : 38
Multiply the extremes and divide by the means.
132 × 38 = 5016 ÷ 128 = 39 3/16   6 + = 45 3/16
which is total depth of needle from skin surface to foramen ovale.

The technic as given for locating the foramen ovale will give gratifying results in nearly every case, unless the foramen ovale is abnormally located. This method has not only proved of inestimable value in locating the foramen ovale for the blocking of the Gasserian ganglion, but also for blocking the third division of the fifth nerve by the extraoral method, as described on page 525.

Locating the External Articular Tubercle.—The zygomatic process arises from the squamous portion of the temporal bone by two roots. Posteriorly, it is divided into a posterior and anterior root. The upper part of the zygomatic process passes backward over the external acoustic meatus and is called the posterior root which continues posteriorly and superiorly joining the supramastoid crest, which outlines the temporal fossa posteriorly. The lower part of the zygomatic process forms the anterior root, and its anterior surface presents a rounded ridge which is called the tuberculum articulare, articular eminence or tubercle. The rounded articular tubercle is located just anterior to the condyle of the lower jaw and inferior-external to the zygoma. (See Figs. 33 and 36.) It is located by palpating the tissues at the lower border of the zygoma 3 cm. anterior to the external auditory meatus with the index finger. Its approximate location can be ascertained by having the patient open and close his mouth several times, observing the condyle during movement of the jaw, then bring the index finger just anterior to the temporomandibular articulation, at which point the tubercle is located. This is a very important landmark while taking the measurements and inserting the needle for blocking the Gasserian ganglion or the third division of the fifth nerve. The soft tissues composed of skin, subcutaneous tissue and muscle, located external to the articular tubercle, differ in thickness with different individuals, the average thickness being 5 mm. In fleshy individuals the tissue may be 10 mm. in thickness, while in the poorly nourished individual, the thickness may not exceed 3 mm. In employing the above technic for ascertaining the distance of the linea intertubercularis, the thickness of the soft tissue on both sides must always be subtraced from the reading of the calipers so the distance will be from tubercle to tubercle, and not from skin surface to skin surface, which would not be accurate on account of the variations in soft tissue thickness.

Smith-Neil Technic for Blocking the Gasserian Ganglion.—Dr. Ewell Neil and the author have spent considerable time in research, endeavoring to improve and simplify the technic for blocking the Gasserian ganglion and to place this surgical procedure upon a more accurate foundation. In evolving the technic many skulls were examined, cadavers injected with methylene blue and dissected, together with clinical experience, after which conclusions were reached as given in the text.

The technic for locating the foramen ovale and the blocking of the Gasserian ganglion is a technical surgical procedure which requires a thorough and intimate knowledge of the anatomical parts. Dr. Neil and the author have searched the literature covering all phases of this subject, in an endeavor to become familiar with all methods which have been presented to the profession. With all due respect to those who have laid a foundation and paved the way in an effort to arrive at a definite technic, there seemed to be no procedure which fulfilled the requirements. The locating of the foramen ovale, on account of its position, has been exceedingly difficult, and this is the keynote to a successful blocking of the Gasserian ganglion. The distance between the puncture point lateral to the angle of the mouth (see Fig. 554) and the foramen ovale is from 6 to 8 cm., which makes it very difficult to locate the foramen by inserting the needle as advocated in the past, for a slight deviation of the needle during its passage through the tissues might result in failure. Such a failure necessitates the partial withdrawal of the needle, a change of its direction and reinsertion until the foramen is located. The technic given here has been evolved after many dissections, a thorough study of the anatomical parts, together with clinical practice, and it is hoped that it will be of value to the profession.

The Triangle.—After arriving at the various measurements, and the distances that the foramen ovale is located from the external tubercle, which has been given, the triangle, shown in Figs. 548 and 549, was devised. This simple device is a great aid in directing the needle from the starting point through the foramen ovale into the Gasserian ganglion. (See Figs. 560 and 561.)

The needle marked 6 in Fig. 560 is of known length (10 cm.) and is advanced through the tissues by the guide marked 13. The triangle is set after the depth of the foramen ovale is known, by passing solid needle 11 through nut 8 (see Figs. 548, 549, and 560), the required distance, and is placed in position. The guide 13, and needle 6, are now set to form the angle, which is accomplished by placing the points of the two needles together, which gives the angle at which needle 6 is inserted. Therefore, the operator knows exactly how far needle 6 is inserted before reaching the point of needle 11, which is located just outside the foramen ovale. (See Fig. 549.) After this point is reached, the operator has a complete check on the location of the point of the needle and advances it the required depth through the foramen into the ganglion and the exact distance the needle has been carried into the ganglion is known. (See Fig. 561.) This part of the technic has been carefully verified by injecting methylene blue into the ganglion of cadavers and the gang-

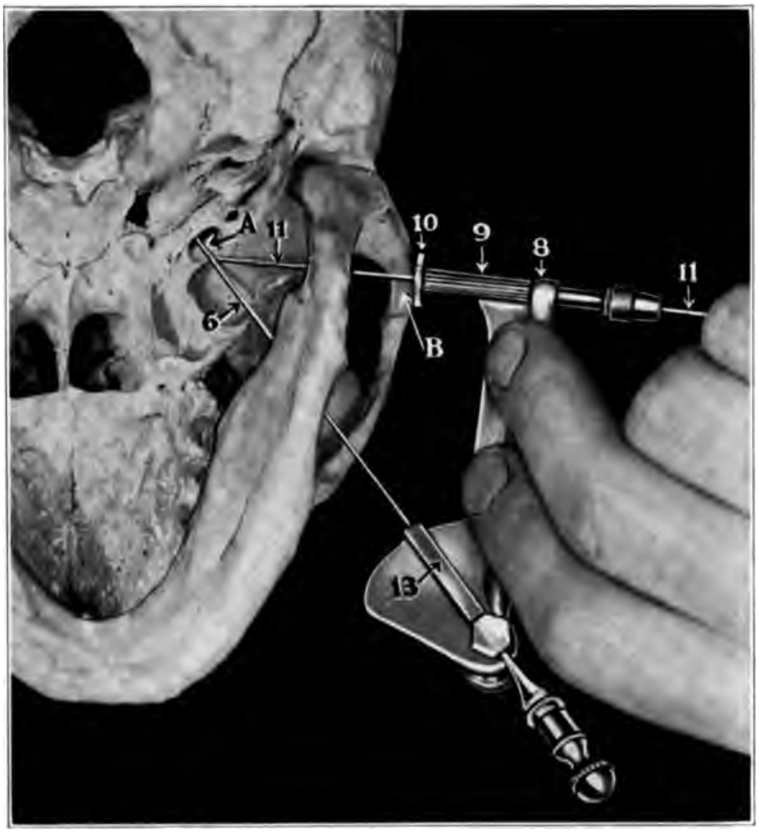

Fig. 560.—Triangle in position on skull.

A, Foramen ovale; B, external articular tubercle of zygoma; 6, needle and stylet inserted through foramen ovale; 8 and 9, guide for solid needle, 11; 10, flattened portion of guide which rests over and below the external articular tubercle; 11, solid needle which forms angle with needle, 6; 13, guide through which needle 6 is inserted.

lion exposed. If the needle marked No. 11 in Fig. 562 is passed into the tissues just beneath the tubercle (see B in Figs. 560 and 563) at right angles to the skin surface until the point is resting over the center of the foramen ovale

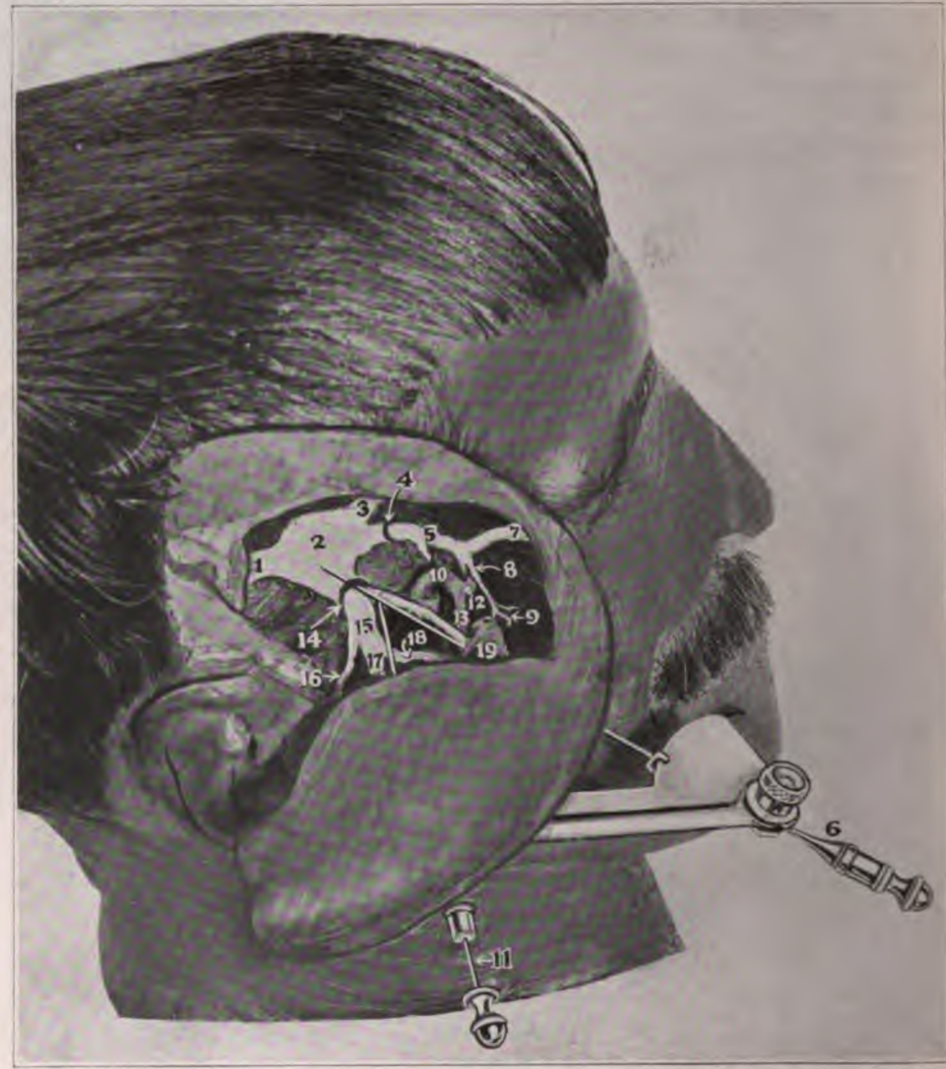

Fig. 561.—Showing triangle and needles in correct position for blocking Gasserian ganglion.

1, Sensory root of ganglion; 2, Gasserian ganglion; 3, first or ophthalmic division; 4, foramen rotundum; 5, second or superior maxillary division; 6, Gasserian ganglion needle inserted through foramen ovale into ganglion; 7, infraorbital nerve; 8, posterior superior dental nerve; 9, posterior superior dental foramen; 10, internal maxillary artery; 11, solid needle; the point is located at the foramen ovale and forms angle with needle 6; 12, sphenomaxillary artery; 13, long buccal nerve; 14, foramen ovale; 15, third or mandibular division; 16, auriculotemporal nerve; 17, inferior dental nerve; 18, lingual nerve; 19, coronoid process of mandible.

(A, Fig. 560), and a perpendicular line is erected, allowing it to pass alongside the cheek, as represented by No. 12 in Fig. 562, opposite the buccal surfaces of the upper molar teeth until a depth of 9 cm. is reached, a base and perpendicular of a triangle are formed. The hypothenuse of this triangle will pass through the cheek opposite the upper first molar tooth between the coronoid process and tuberosity of the maxilla (see No. 6 in Fig. 563), directly into the foramen ovale at an approximate depth of 7 cm. The base of the triangle, No. 11, Fig. 562, is capable of being adjusted to form various angles, and the hypothenuse is adjustable to form any angle necessary, which is easily adjusted for any fleshy or thin patient. Fig. 559 is self-explanatory for it shows the various angles which can be formed.

No. 10 is against the skin surface when solid needle No. 11 is inserted under the tubercle of the zygoma. (See Fig. 562.)

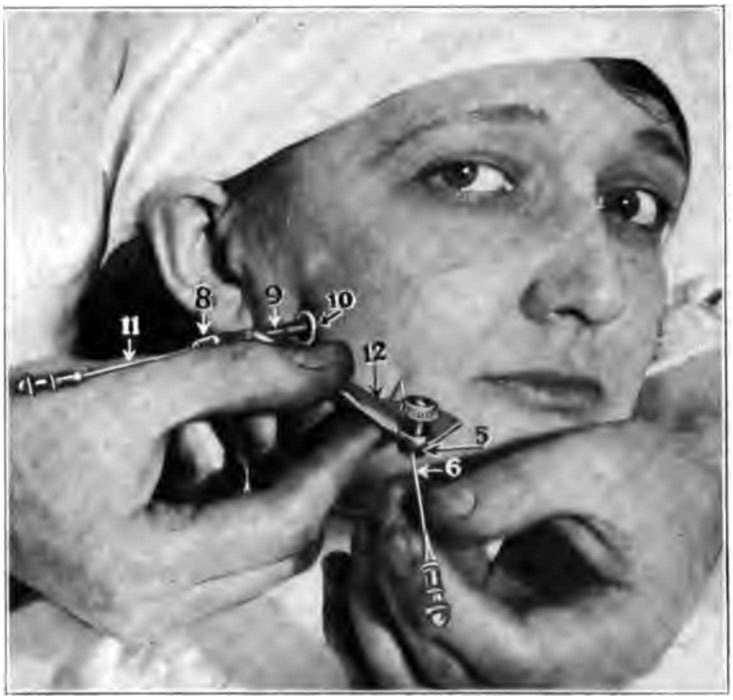

Fig. 562.—Appliance in position as needles are advanced into the tissues.

5, Lock nut to hold guide for needle, 6; 8, lock nut to hold solid needle, 11, after it is passed through guide, 9; 10, flattened portion of guide resting over and below external articular tubercle; 12, perpendicular of triangle.

Fig. 559 illustrates the distance from 10 to 1, 2, 3, or 4, representing various depths from skin surface at which the foramen ovale may be found, viz., 3½, 4, 4½, and 5 cm.

Nos. 5 to 1; 5 to 2; 5 to 3, and 5 to 4 are the various hypothenuses necessary to complete the triangles with the bases 9 to 1; 9 to 2; 9 to 3, and 9 to 4.

The solid needle No. 11 is graduated, and each graduation represents 5 mm. inserted through the vise nut 8 to show the depth at which the foramen ovale is found. Knowing this depth, it is easy to adjust the indicator at 5 to form the proper hypothenuse to complete the triangle.

Technic of Injection.—The external articular tubercle is located on both sides, using the calipers as illustrated. (See Fig. 558.) The same example will be used here as is given on page 813. The average distance is found to be 138 mm. from skin surface to skin surface, and the thickness of the soft tissues covering the tubercles is 5 mm., which has been ascertained by inserting a needle at right angles to the skin surface, which gives 10 mm. for both sides; therefore, subtract this from 138, which leaves 128 mm., the distance of the linea intertubercularis. Now, take 19/64 of 128, which gives 38 mm. This represents the distance from tubercle to foramen ovale. To this add 5 mm., the soft tissue measurement on one side, which makes 43 mm. which represents the distance from skin surface to the center of the foramen. After arriving at this measurement, the solid needle 11 (see Fig. 559) which is graduated, is passed through guide 9 to the distance of 43 mm., after it has passed part marked 10, and is locked in position by nut 8, while needle 6 is adjusted at the proper angle. It must be remembered that 43 mm. are used

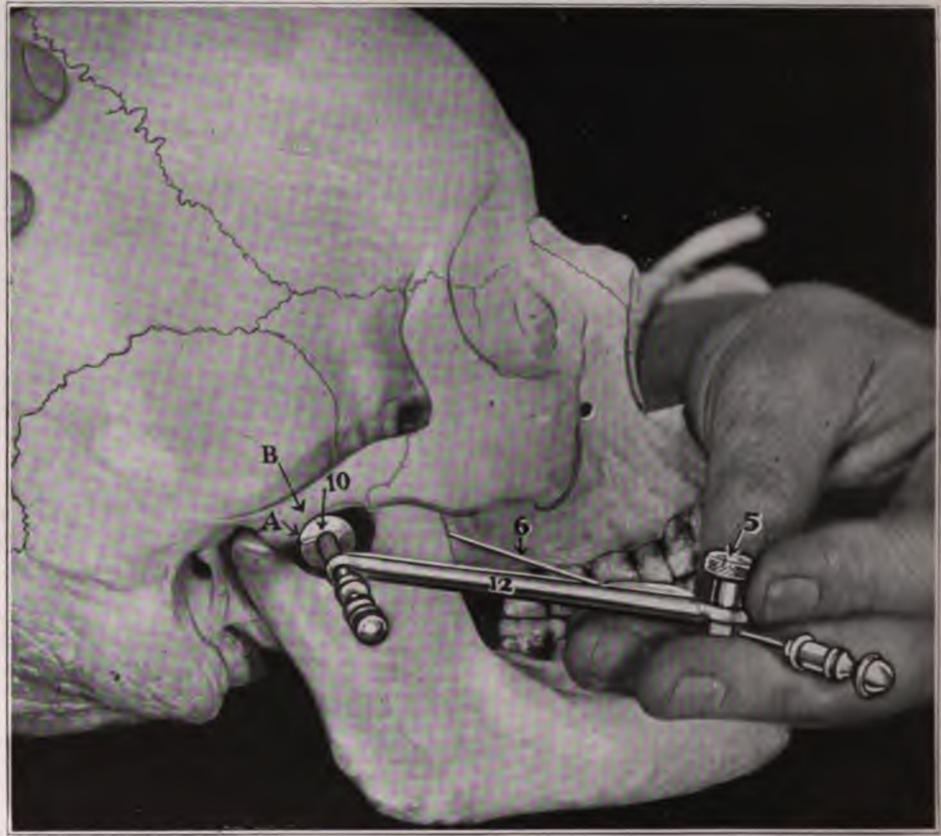

Fig. 563.—Lateral view of triangle and skull.

5, Lock nut to hold guide for needle, 6; 10, flattened portion of guide resting anterior and below external articular tubercle, indicated by A; 12, perpendicular of triangle; B, zygoma.

here only as an example, and is the average distance that needle 11 is inserted in order to reach the foramen. Needle 6 is now adjusted to meet point of needle 11, after which nut 5 is locked to hold the guide for needle 6. Nut 8 is then loosened, and needles 6 and 11 are withdrawn. If alcohol is to be injected without the patient being under a general anesthetic, two preliminary injections are made, one directly over the tubercle and the other in the skin opposite the first molar tooth, which will be approximately 3 cm. to the lateral and slightly above the corner of the mouth. (See Fig. 562.) Use two mils of solution for each injection. Each injection will produce a wheal 2 to 3 cm. in diameter. In accordance with our example, after waiting 5 minutes for anesthesia of the skin, etc., carefully adjust part 10 external and below the tubercle (see Fig. 562 and 563), and insert solid needle 11, 43 mm. at right angles to the skin surface and tightened by lock nut 8 (see Fig. 564). The needle point should be just outside the foramen ovale (see Figs. 560 and 561). The patient will experience radiating sensations in the lower jaw when the mandibular or third division of the fifth nerve is reached. The perpendicular of the triangle, which is marked 12, is now held alongside the cheek of the patient until the end of the guide touches the skin opposite the upper first molar, approximately 3 cm. to the lateral and slightly

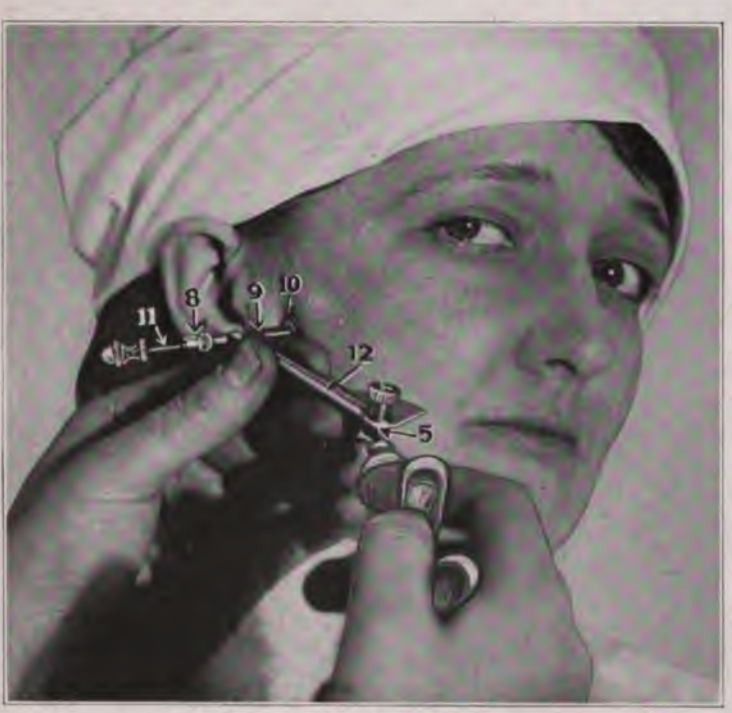

Fig. 564.—Illustrating the triangle in position while injecting the solution into the Gasserian ganglion. 5, Guide for needle; 8, lock nut which is holding the solid needle, 11, in guide, 9; 10, flattened portion of guide resting over and below the external articular tubercle; 11, perpendicular of triangle.

above the corner of the mouth. Now hold the appliance firmly in this position, as shown in Fig. 562, and direct needle 6 through guide 13 (see Fig. 560), which has been previously set, advancing it through the tissues towards the foramen, the distance of which has been previously calculated and is easily ascertained by observing the graduations on the needle. Therefore, the operator will know when the two needle points have completed the triangle just outside the foramen ovale. After this is accomplished, advance the needle one-half to three-quarters of a centimeter farther through the foramen (never to exceed one centimeter) into the Gasserian ganglion. (See Fig. 561.) As needle 6 is being advanced, it should be rotated to avoid deviation in the tissue which may be caused by the bevel of the needle.

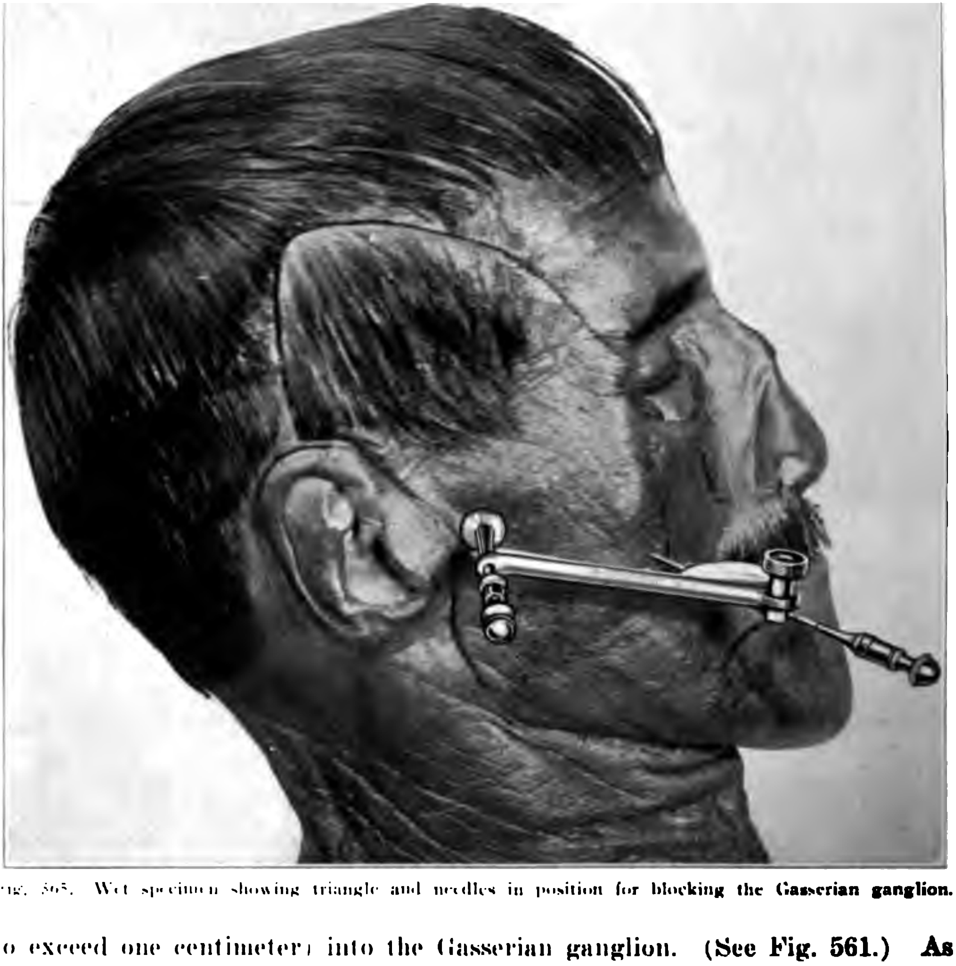

Fig. 563. Wet specimen showing triangle and needles in position for blocking the Gasserian ganglion.

If alcohol is to be injected for treatment of tic douloureux, first inject two mils of a 2 per cent procain suprarenin Ringer solution, remove the syringe and wait 15 minutes for anesthesia, after which adjust syringe and slowly inject two mils of alcohol, distributing it from foramen to center of ganglion. (See Fig. 564.)

If injection is not for treatment of tic douloureux, but is for operative surgery, inject 3 mils of a 2 per cent procain suprarenin Ringer solution, and anesthesia will quickly follow in all three branches of the fifth nerve and will last from 1 to 2 hours.

The object of the triangle is not to locate the foramen ovale, but to direct the needle to and through the foramen and to have a complete check on the exact location of the needle point at all times.

The measure of success which the operator is to achieve in passing the needle into the foramen with this appliance will depend largely on his skill in locating the foramen ovale.

The hypodermic needles being graduated, will enable the operator, by referring to these graduations, to know when the needles have gone deep enough to complete the triangle; or, in other words, to know when the point of needle 6 has reached the point of needle 11.

If the operator fails to stop point of solid needle 11 at the foramen ovale, the hypodermic needle 6, when inserted through guide 13, will not form an angle with solid needle 11, but will in most cases strike the smooth infratemporal surface of the sphenoid bone just in front of the foramen ovale and fail to enter it. (See Fig. 560.) If this should happen, it proves that the foramen ovale has not been located by the solid needle 11, and before making another effort the partial withdrawal of both needles is necessary.

If this method as outlined is understood and properly executed, it will enable the operator to find the exact location of the foramen ovale. This geometrical problem will tell the operator the exact distance to the foramen and the exact location and depth of the needles at all times.

It was found by injecting methylene blue at the anterior inferior margin of the Gasserian ganglion, that is, by having the point of the needle located just interior to the foramen ovale, that upon dissection, the solution had infiltrated and even reached the walls of the cavernous sinus. However, it is not advisable to inject the alcoholic solution at the anterior inferior margin of the ganglion, but to insert the needle upward and inward to a distance of one cm. after it passes through the foramen ovale. At this depth the needle will penetrate the ganglion itself, and when the solution is injected a more profound anesthesia will be secured. (See Fig. 561.) If the solution is injected just inside the foramen ovale, there is always some possibility of it not reaching all of the nerve fibers and cells which make up the Gasserian ganglion. If this is the case, only partial anesthesia results. For example, if the patient is suffering from tic douloureux caused by some pathological condition existing somewhere in the region of the second division of the fifth cranial nerve and the solution did not reach the fibers comprising the second division, the patient would be given little or no relief.

Harris, of London, advises that the solution should be injected just interior to the lips of the foramen ovale, and says it is not necessary for the needle point to enter the ganglion itself. The writer does not agree with him in this respect, but prefers to insert the needle through the foramen ovale an approximate distance of 1 cm., penetrating the ganglion itself, as shown in Fig. 561, injecting one mil of alcohol to block the sensory root, and as the needle is withdrawn inject another mil. Harris is quoted as follows:

"It is important to inject only a few drops of the alcohol at a time and to wait at least two minutes before testing the anesthesia on the forehead before injecting any more. As soon as total anesthesia develops over the forehead and eyeballs, there is a possibility that the damage to the ganglion may be so great that the total anesthesia does not evaporate; as is actually the case, though in the majority of cases as much as .5 mil of alcohol may be further injected and total anesthesia ensues without risk of its being permanent. When a total of more than one-half mil has been injected, this risk is a very real one, and if total anesthesia still persists half an hour after the injection, the eyelids should be closed by adhesive plaster, pad and bandage, in order to guard against the risk of keratitis developing, which is certain to appear on the following day, if total anesthesia is still present. If, however, sensation is still returning in the first division and pressure on the eyeball can be felt definitely, then the risk is passed."

"A curious point, which I am unable to explain, is that after the ganglion injection, the anesthesia in the first division is more intense and more lasting than in the second or third division, a point which is peculiarly unfortunate, owing to its dependent keratitis."

The writer does not prefer to inject the solution just inside the foramen ovale, and contends it is far better to force the needle into the ganglion itself. Harris also states that anesthesia of the first and second divisions began to fade away in a few minutes following the injection. Undoubtedly this was due to the fact that he injected the solution in the region of the anterior inferior part of the Gasserian ganglion, and in reality the fibers composing the first and second branches of the fifth nerve did not receive a sufficient quantity of the solution to thoroughly permeate them; or, in other words, only an analgesia was produced, due to an insufficient amount of the alcoholic solution reaching them.

Symptoms Following Alcoholic Injection of Gasserian Ganglion.—No im mediate symptoms follow the injection of alcohol, provided the part is blocked with a local anesthetic before injecting the alcohol. However, as soon as the local anesthesia disappears, certain phenomena present themselves as a result of the alcoholic injection. By many patients a feeling of fulness or a slight burning pain is experienced in the region of the orbit and the vertex of the head. However, this is not so apparent if the alcoholic injection has been preceded by an anesthetic injection to eliminate the pain following the latter. If no block injection with a local anesthetic solution has been made, but only a solution of alcohol plus a local anesthetic and other ingredients has been injected, the presence of anesthesia is indicated by pricking the skin with a pin, it being interesting to note that anesthesia of the skin becomes apparent within a few minutes after the first alcoholic solution has been injected.

As previously stated, following an alcohol injection into the ganglion or nerve trunk, little or no sensation is manifested by the patient, provided the alcoholic injection has been preceded by a procain suprarenin Ringer solution injection. Some patients experience a sensation of a burning character, lasting only a few minutes, which is usually followed by a subjective numbness. There will be paresthesia, which is described by the patient as a crawling sensation over the entire distribution of the nerve trunk injected. This is followed by a sensation of fulness or stiffness over the side of the face which has been blocked. Numbness remains from one to three weeks and then gradually disappears. The tactile sensation returns, but with a complete loss of pain sense. The sense of taste is impaired and weakness of the muscles of mastication is manifested on account of the motor fibers supplying them being blocked. Some swelling of the eyelids may take place, but usually subsides in two or three days. Many times the patient will have a temperature of 102° or 103°, but this subsides very quickly. Traces of anesthesia may remain for six months or longer. If the injection has been unsuccessful, the patient will still suffer pain, and the injection should then be repeated as soon as the reaction has subsided from the first injection. When making an injection on a patient, it is a wise policy to always tell the patient that it may be necessary to make more than one injection to give him relief. In case two nerve trunks are involved, they can both be injected at the same operation if the patient is in a good physical condition. The trunk which is causing the most pain should be injected first. This injection may eliminate or lessen the pain in the other branch. However, the nerve trunk which gave the patient the least amount of pain may rapidly develop a much worse condition than before the painful trunk was injected.

If the alcohol reaches the motor nerve fibers located below the sensory fibers in the third division, a certain amount of paralysis will be produced in the muscles of mastication. The paralysis of these muscles on the side of injection may be complete or partial, and may interfere somewhat with the patient's masticating on the side blocked. In most cases the patient will learn to masticate very quickly on the unaffected side, which, after all, is not a great handicap. The patient should be instructed and cautioned against injuring the mucous membrane inside the cheek or tongue by biting, which is easily done, these parts being anesthetized. However, the patient will accustom himself to the numbness until partial or total tactile sensation returns. Paralysis of the part in most cases is not noted by the patient after a few weeks. In some instances it may be noticeable to a considerable extent, while in others it may be an inconvenience to the patient. The reader's attention is called to the fact that if the alcoholic solution is injected into the Gasserian ganglion itself, or better still, into the sensory root of the Gasserian ganglion, the motor branch occupying a position inferiorly to this point will not receive the full effect of the alcoholic injection; in other words, only a partial destruction may take place in the motor fibers, which is advantageous when we consider that their function is to supply the muscles of mastication with motor impulses. The motor sense or motor impulses return much quicker than the sensory impulses and, in many cases, the motor paralysis is hardly noticeable by the patient a few weeks following the injections.

Effects Following an Alcoholic Injection.—If the needle has been inserted too far, or, in other words, if it has been advanced through the Gasserian ganglion, and the solution injected, the patient may experience severe pain in the region of the injection and in the occipital region; also vertigo, dizziness, nausea and vomiting may occur. If an excess amount of the solution has been injected, or if it has been injected in the wrong place, nystagmus may be caused or the pupil may become dilated and paralysis of the sixth cranial nerve may result. These symptoms may be due to the solution penetrating the outer wall of the cavernous sinus, thereby reaching the various nerves supplying the eye. If the patient experiences deafness or a facial paresis, it may be that the alcohol was injected at such a location as to reach the facial and auditory nerves. If the Gasserian ganglion has been properly injected, the patient may experience symptoms which to a certain extent are similar to a Gasserectomy. Anesthesia of the cornea is present, and the patient must guard against injuring this structure; also prevent foreign material entering the eye, for with the loss of sensation, dirt may enter and infect it. Keratitis may result in some cases following the Gasserian injection. It is always advisable, before making a Gasserian ganglion injection, or any other deep injection, to advise the patient of the postoperative complications which may follow, such as numbness, anesthesia, motor paralysis, dilatation of the pupil, nystagmus, anesthesia of the cornea, keratitis, etc. In case the cornea is anesthetized, it is advisable to close the eyelids and hold them together by means of adhesive plaster, the adhesive plaster being removed each day, the eyelids opened, and the eye syringed with an antiseptic solution, such as boric acid. If anesthesia should last for several days, great care should be exercised not to damage the eye by improperly placed gauze packing or cotton pads, or not to allow the eye to remain open, inasmuch as anesthesia is present and the patient will not be aware of the presence of foreign material, which may cause considerable damage.

Dr. Carroll W. Allen in a paper read before the Southern Surgical Association, Dec. 1919, says:

"It has been found that chromium sulphate exerts a curative influence on the keratitis which sometimes follows these injections. Accordingly, I have been giving all of my recent cases a four grain tablet of this remedy, three times daily, as a prophylactic, advising its use for about one month. Whether this last procedure has exerted any controlling influence on the eye inflammation, or whether the cautious tentative method of injection deserves the credit, I am unable to state, but in my last twelve cases there has been no evidence of eye inflammation."

Dr. Allen in speaking of alcohol injections of the Gasserian ganglion and its branches in cases of inoperable malignancy of the face, tongue and jaws, says: "From my experience, I am convinced that when the value of these injections for these conditions is recognized, they will be extensively used, as any method which affords such marked relief is a blessing to these unfortunates in allowing them to retain their mental faculties unclouded by morphin until the disease has advanced to such a point that narcotic oblivion is to be preferred."

BLOCKING THE GASSERIAN GANGLION WITH PROCAIN SUPRARENIN RINGER SOLUTION FOR SURGICAL OPERATIONS

The blocking of the Gasserian ganglion with a local anesthetic solution does not differ from that of injecting alcohol for treating tic douloureux. The writer advises 3 mils of a 2 per cent procain solution. Anesthesia will be secured in all parts supplied by the entire fifth nerve. There will be complete anesthesia of the upper and lower jaw, teeth, antrum of Highmore, floor of the mouth, anterior two-thirds of the tongue, alveolar process and bone, etc.; also the structures within the orbital and nasal cavities are anesthetized. Therefore, a resection of the superior maxillary bone, or an operation which involves the soft tissue or bones forming the nose and orbit, can be performed. Radical antrum operations, resection of the alveolar process, removal of a tumor, or reduction of a fracture may be accomplished. There is partial anesthesia of the tonsils and soft palate; the anterior and posterior pillars of the tonsils are anesthetized and can be removed, provided the pharyngeal plexus has been blocked at the posterior lateral base of the tonsils as described on page 774.

IMPORTANT BLOCK INJECTIONS FOR TIC DOULOUREUX

The most important deep block injections for treating tic douloureux are:

1. Second or superior maxillary division injection by the intraoral method. (See technic, page 380.)
2. Second or superior maxillary division injection by the extraoral method. (See technic, page 396.)
3. Third or mandibular division injection by the extraoral method. (See technic, page 525.)
4. Inferior dentolingual injection. (See technic, page 531.)
5. Gasserian ganglion injection. (See technic, page 814.)
6. Infraorbital injection. (See technic, page 459.)

In addition to the above-named injections which are the most important, other nerve branches are occasionally blocked.

SPHENOPALATINE (MECKEL'S) GANGLION NEURALGIA

Recently Sluder revealed his findings with reference to neuralgia of Meckel's ganglion, and has called the attention of the profession to a pain syndrome. He states that undoubtedly the pathology is due to irritation of this ganglion and that this form of neuralgia is somewhat common. The following description of the pain syndrome will, no doubt, throw considerable light on many obscure cases which have been met with in the past. He says:

"When seen from the beginning, the pains of postethmoidal or sphenoidal diseases have usually preceded the development of the characteristic neuralgia picture. I have also remarked that after the neuralgic manifestations have continued for some time (approximately four weeks), they begin to run irregularly, assuming the form of migraine which may persist even for years, after all local inflammatory conditions have disappeared.

"One of the most striking manifestations of disturbance in the sphenopalatine ganglion is the wide and characteristic distribution of pain along definite lines. These neuralgic manifestations can be evoked by mechanical irritation of the ganglion, by the faradic current, and by therapeutic injections of alcohol. The neuralgia is described as a pain at the root of the nose, sometimes also in and about the eye, taking in the upper jaw and teeth; sometimes, also the lower jaw and teeth and extending beneath the zygoma to the ear to take on the form of earache. It is very marked at the mastoid, but is nearly always severest at a point about two inches posterior to the mastoid, thence reaching backward by way of the occiput and neck; and it may extend to the shoulder blade and shoulder, and in severe attacks to the axilla, arm, forearm, hand, and fingers. This is the most frequent picture, as I have observed it. Sometimes the patient complains also of a "stiff" or "aching" throat, without inflammation; of pain, or oftener of itching in the roof of the mouth; or, of pain inside the nose.

"Along with the pain there is also, on the affected side, slight anesthesia of the soft palate and of the pharynx as far down as the lower part of the tonsil and also in the anterior lower part of the nose.

"In a large percentage of cases, the neuralgia is accompanied by motor disturbance, affecting the configuration of the soft palate. The palatine arch on the affected side is often higher than on the well side, and during movement, the median raphe is deflected from the affected side. Taste is usually less acute on the dorsum of the affected side."

Blocking the Sphenopalatine (Meckel's) Ganglion.—Sluder in his recent investigations found that neuralgia was occasionally due to irritation of the sphenopalatine ganglion, which makes it necessary in some cases to block this ganglion in the treatment of tic douloureux. It is seldom, if ever, necessary to block the sphenopalatine ganglion for surgical operations except for tonsillectomy and operation on the nasal septum. However, since it has been made known that the sphenopalatine ganglion is involved many times in trifacial neuralgia, it must be blocked. Sluder injects this ganglion by inserting the needle through the vertical plate of the palate bone through the nose. In the writer's opinion, this is a very uncertain method of reaching the ganglion and requires greater skill than to insert the needle posterior to the tuberosity of the superior maxillary bone by the technic given on page 773.

THE SLUDER-BLAIR METHOD FOR BLOCKING THE SPHENO-PALATINE GANGLION

The following technic is for blocking the ganglion by the extraoral method: The needle is inserted into the skin inferiorly to the malar bone, directly below the angle which is formed by the temporal border of the malar bone and the upper border of the zygoma. The direction of the needle is slightly upward and backward and almost directly inward until the pterygoid process is reached. When the pterygoid process is encountered, the needle is then carried in the sphenomaxillary fossa. The direction of the needle is now changed and is advanced anterior to the pterygoid process and is inserted 5 mm. deeper. The alcoholic solution is now injected slowly by working the needle up and down in the fossa. The distance from the zygoma to the external pterygoid plate is, in the average case, according to Sluder and Blair, 43 mm.; so taking 43 mm. as the average depth, plus 5 mm., the distance the needle is forced inward, after leaving the pterygoid process, would make a total of 48 mm. in the average case. If inserted too deeply, there is danger of its entering the orbit through the sphenomaxillary fissure, and if the solution should be injected in this region, postoperative complications may arise.

AUTHOR'S TECHNIC FOR BLOCKING THE SPHENOPALATINE GANGLION

The author advises, before employing any method for blocking this ganglion, that the operator review his osteology and anatomy of Meckel's ganglion as to its position, nerve branches and their relationship to other structures. The anatomical location and description of this ganglion and its branches are found in Chapter VII entitled "Nervus Trigeminus." This ganglion is situated 5 or 6 mm. beneath the second division of the fifth nerve as this branch bridges the pterygopalatine fossa. The reader is referred to page 773 for technic.

Amount of Solution Injected.—If alcohol is injected into the sphenopalatine ganglion, 1 mil is employed. If a local anesthetic solution is used, 4 mils of a 1 per cent solution are injected to block for tonsillectomy, etc.

Advantages of Intraoral Method.—The advantages of this method over the extraoral method are that it is more difficult to force the needle through the sphenomaxillary fissure into the orbital cavity, besides the distance of carrying the needle through the tissue is less than half the distance required by the extraoral method. Little or no pain is experienced by the patient when the intraoral route is employed.

CHAPTER XXXV

POSTOPERATIVE COMPLICATIONS—AFTER-PAIN, CAUSES AND TREATMENT; BROKEN NEEDLES AND THEIR REMOVAL; HEMATOMA

POSTOPERATIVE COMPLICATIONS—AFTER-PAIN

Postoperative pain and complications are due to the following factors:

1. To the operation itself.
2. To the reaction of the pathological tissue.
3. To the local anesthetic which has not been properly administered.

General Considerations.—The factors that are concerned in the production of pain can be broadly classified in their origin as general, local, and psychic. There is no question but that the sensibility to pain arises or is produced through the activity of the autonomic nervous system, referred to the terminal nerve fibers, which are diffusely distributed throughout the entire body, and that the sensibility to pain of the various tissues of the body is dependent upon the distribution of the nerve supply. For example, the skin, conjunctiva, gum tissue, peridental membrane, etc., are highly sensitive, whereas such structures as the mucous membrane, muscles, ligaments, alveolar process and bone have very little sensation.

Anoci-Association.—To combat postoperative pain, a definite technic must be followed. Such a technic has been carefully worked out by Crile in his classical researches known as anoci-association. The principles laid down by Crile, if carefully followed, have no parallel in producing gratifying postoperative results. Briefly, Crile's technic of anoci-association is to eliminate all adverse factors which tend to increase mortality or to prolong the postoperative recovery of the patient. First, the patient receives the proper preoperative treatment. A preliminary sedative is administered, such as morphin and atropin, and both general anesthesia and block anesthesia are employed. After the patient is anesthetized with nitrous oxid oxygen, the operative area is completely blocked with a local anesthetic; therefore, all painful, detrimental, afferent impulses are prevented from reaching the brain. (See Fig. 566.) Plenty of time is taken during the operation, the tissues are delicately manipulated, and thoroughness is never sacrificed for speed. Following the operation sedatives are administered if necessary. Postoperative pain depends largely upon the susceptibility of the patient and is influenced by temperament, psychic state, physical condition and nationality. (See page 851.)

After-pain depends a great deal upon the tissues involved and the nature of the operation. If the operation involves tissues which are richly supplied by sensory nerves, or have undergone an inflammatory process, considerable postoperative pain may result unless counteracted.

Many peculiar factors enter into the production of postoperative pain. For example, a similar technic can be used on the same patient for the extraction of the lower right and left impacted third molars, yet in some cases the patients will complain of severe postoperative pain on one side only. Some of these cases are rather difficult to explain. Strict asepsis should always be practiced. Every precaution should be taken, such as the sterilization, as far as possible, of the field of operation, the hands, instruments, dressings, etc. The employment of a sterile, physiologic, isotonic Ringer, local anesthetic solution injected slowly will help to preserve the tissues and tend to prevent after-pain. (See Figs. 210, 218-D and 218-E.) Careful manipulation of the tissues during the operation will eliminate trauma, laceration, and shock, and should be practiced at all times. An operator should never sacrifice thoroughness for speed while operating under block anesthesia. In some operations for oral surgery it is better to use the combination of block anesthesia and general anesthesia, thereby preventing the afferent impulses from reaching the brain.

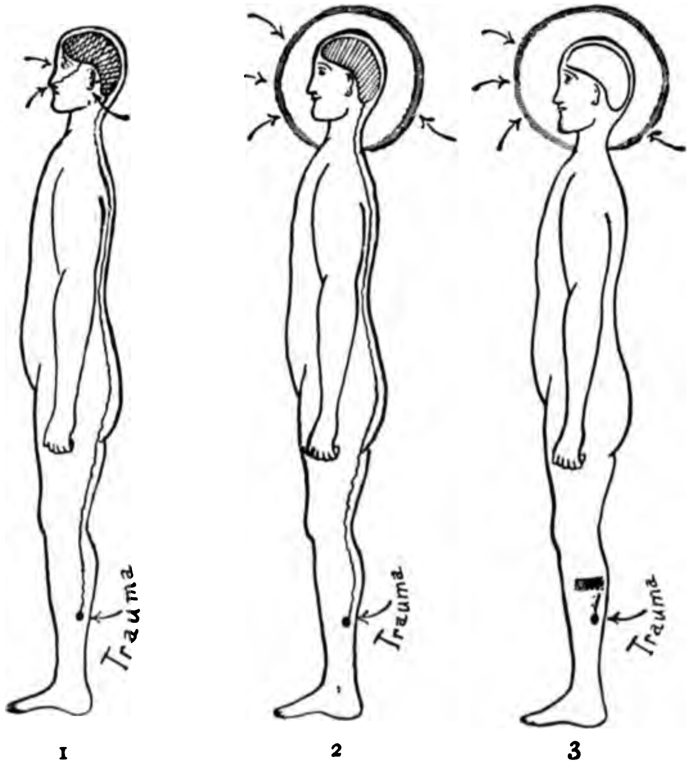

Fig. 566. Anoci-association diagram; 1, auditory, visual, olfactory and traumatic anoci impulses reaching the brain; 2, auditory, visual, olfactory associations excluded; 3, nerve blocked, patient in anoci-association. (After Crile.)

The subject of postoperative pain and its elimination is of great importance, and the operator should give its causes and the treatment careful attention, and above all, he should try to avoid pain after operation.

Dr. J. P. Henahan, of Cleveland, Ohio, makes the following statement in regard to postoperative pain: "In my opinion, the proper way to take care of after-pain is to prevent it." Dr. Henahan is correct in making that statement, but many times it is impossible to prevent after-pain; therefore, when it occurs we must combat it in the best possible manner.

Wounds which result from the removal of badly impacted third molars, and dressings that are packed in these sockets under pressure, are in most cases contraindicated, as in many instances they produce irritation, cause inflammation, and increase after-pain. In the majority of cases it is far better to rely on the blood clot as a dressing and to irrigate as indicated. If a dressing is to be employed, several antiseptics as well as anodyne combinations are at the disposal of the operator. Following the surgical removal of a tooth, say an impacted third molar, or the surgical removal of other teeth, occasionally a dry socket prevails, which leaves the surface of the alveolar wall unprotected, producing pain because the sensory nerve endings are exposed to the fluids of the oral cavity, and to infection. In the opinion of the writer, a sterile blood clot in the alveolus following extraction of a tooth in the majority of cases is the best possible dressing, and in many instances it is preferable to allow the blood clot to remain without inserting a gauze pack or obtundent. However, the operator must use his own judgment, and all factors must be carefully considered as to the amount of tissue involved, the nature of the operation, and the inflammation which may follow, etc. (See formula for obtundent paste on page 838.)

POSTOPERATIVE PAIN DUE TO AN IMPROPERLY INJECTED LOCAL ANESTHETIC

1. The first and most important factor is injecting a solution which is not isotonic with the tissue fluids and blood. A hypertonic solution, when injected, exerts a greater osmotic action than the isotonic solution, and has the power, on account of its concentration, to absorb water from the surrounding tissue cells. This causes a contraction of the tissue cells, which continues until the hypertonic solution injected is reduced to an isotonic solution (see Figs. 213, 216, 218 and 218-C). Such changes in the tissue cells cause postoperative pain. (See hypertonic solution on page 333.) The hypotonic solution when injected causes just the opposite effect to that of a hypertonic solution, that is, expansion of the tissue cells. (See Figs. 211, 215, 218-A and 218-B and the hypotonic solution on page 333.) In the textbook of Fischer and Riethmüller they advise the use of an isotonic Ringer vehicle in preference to a vehicle made from sodium chloride alone.

2. From injecting the solution too rapidly into the tissues. This causes rapid distention or "ballooning" of the tissues which results in tissue injury.

The solution should be injected slowly. Rate, 15 seconds per mil. The needle should be moved slightly back and forth during the discharging of the solution.

3. From injecting the solution into muscle tissue or a ligament.

4. From injecting drugs which have deteriorated.

5. From employing a stock anesthetic solution which contains preservatives, such as acids, thymol, etc.

6. From injecting a too hot or too cold solution. The wide difference in temperature causes pain. The solution should be near that of body temperature (98.6° F.) when injected. (See Fig. 212.)

7. By injecting under pressure a quantity of solution beneath the periosteum, which causes some separation of the periosteum from the bone, besides the damage done by needle.

8. Infection due to employing an anesthetic solution which is not sterile.

9. Infection due to employing a septic needle or syringe.

10. Infection due to carrying bacteria on the needle from the mucous membrane or saliva into the tissue, due to improperly prepared field.

11. From repeated punctures of the tissue by the needle, or by withdrawing the needle and changing its direction several times.

12. From excessive massage of the tissue over the point of injection, such as the mental, incisive, and infraorbital regions.

13. In case the solution contains the proper amount of suprarenin content, the connective tissue in the region of injection will absorb it. If the vaso-constricting agent is in excess, absorption takes place very slowly. This may cause edema, swelling, false ankylosis, difficult deglutition and pain. This is noted mostly following some inferior dentolingual injections in case the solution is injected into the internal pterygoid muscle.

14. Edema and after-pain may not only be caused by the factors mentioned above, but may be due to the operation itself, such as trauma, laceration, the incising of the tissue, the chiseling or cutting the alveolar process as required in the surgical removal of many impacted third molars. It may be due to a combination of factors, and the operator must always consider all possible causes before placing the blame on any factor.

15. Postoperative pain may be due to the vasodilatation of the arterioles after the constricting action of the suprarenin or adrenalin has disappeared. Such a dilatation is accompanied many times by an actual exudation of serum, and is augmented sometimes by the escape of erythrocytes.

16. The degree of after-pain is not only dependent upon the factors enumerated, but upon the drug employed as the anesthetic, the vaso-constricting agent, method of injection, amount injected, and the kind of tissue injected.

If the correct technic is followed, and the injecting solution consists of the proper ingredients and is properly prepared and injected, little or no pain will be experienced by the patient.

Postoperative pain may be present in some individuals even if the best technic has been employed, and in such cases it is no doubt due to the hypersusceptibility of the tissue to slight trauma, such as the discharging of the solution, or from the minor injury produced by the needle itself. Unfortunately there are great individual variations which contribute to the inconstancy of results, and many such cases defy analysis.

Pain is the result of tissue injury, and manifests itself by discomfort and suffering caused by the injury to the sensory nerves, nerve cells, or sensory end organs. Sensory nerve injury is transmitted by afferent impulses to the brain and is there interpreted as pain, and the degree depends upon the susceptibility of the individual, the number and character of stimuli. Therefore, after-pain may be defined as the sum total of all unpleasant sensation the patient experiences as the immediate results following a surgical operation. The abnormal sensation the patient experiences in some cases may be directly due to trauma and injury of the tissue which may be brought about by the local anesthetic injected, or from the necessary steps required to perform the operation. This subject should be considered in a very comprehensive manner, particularly in the light of oral, throat, plastic and dental operations. There can be no question but that operations performed within the oral cavity may become more or less complicated by infection developing from foods and liquids as the region they occupy must be traversed by all the elements that go to sustain life, and therefore, their function cannot be arrested for any length of time.

This subject will now be discussed under four specific heads, as follows:

1. Postoperative pain resulting from trauma and the severance of tissue.

2. Postoperative pain resulting from compressing and traumatizing the tissue by means of artery forceps, sutures, etc., to restore the continuity and to check hemorrhage.

3. Postoperative pain resulting from an inflammatory reaction in the tissue which is infected about the wound, if the operation is within the oral cavity. This third factor depends upon the location, character, and extent of infection, but some infection is present in nearly all oral operations.

4. The fourth group of factors which cause postoperative pain are more or less general in character, such as pain on deglutition, headache, trauma, pain which is located in the part, due to the injection of the anesthetic, but more frequently may be attributed to the operation itself. Nevertheless it may be due to the combination of both.

Postoperative Pain Resulting from Trauma and the Severance of Tissue.—Postoperative pain following traumatism and the severance of tissue is quite an important factor to consider. It is a well-known fact that tissue which contains sensory nerves, when operated upon, produces a burning pain which usually lasts three or four hours, and is due to the severance of the tissues, thus exposing and traumatizing delicate sensory nerves. The amount of pain depends upon the kind of tissue operated. Some kinds of tissue contain more sensory nerve terminals than others. The oral surgeon is very fortunate when he realizes that the tissues about the mouth are not as sensitive as other tissues of the body.

The sensory nerve branches in the region of the pharynx, larynx, and oral cavity, such as the branches of the trigeminus and pharyngeal branches, are usually protected from trauma during an oral operation. Postoperative pain that is caused by the mere incising of the tissue is the least of the causes of after-pains. If anesthesia is not employed, and the incision is made, intense pain is produced at the time of making the incision, and the patient experiences an unpleasant burning sensation which is eliminated by the production and duration of block anesthesia. As we have previously stated, pain is due to the severance and exposure of nerve endings and in order to guard against it, the sensory nerve endings must be protected from the fluids of the oral cavity, air, etc., by bringing the parts together and applying medication.

Postoperative Pain Resulting from Compressing and Traumatizing Tissue.—Traumatizing the tissue by ligation of arteries, suturing, clamping of arteries with artery forceps, and the constriction of tissue all produce more or less tissue injury, which is bound to cause after-pain. The postoperative pain which the patient experiences following a freshly made incision is not only due to the severing of the sensitive nerve endings themselves, but is likewise due to the pressure of ligatures and sutures when they have been employed, as well as the chiseling or cutting of the bone in operations where such a procedure is indicated. The pain which results from constriction of the sutures or the ligatures may be prolonged from a few hours to several days, depending upon the location of the operation and the amount of tension the suture exerts on the sensitive tissue. A nerve branch should never be included within a ligature as when tying off a blood vessel. The blood vessel should be carefully isolated from the nerve branch before resorting to ligation. However, in some instances the blood vessels may have so many sensory nerves near them that it will be almost impossible to separate them from the bleeder for ligating. Only a minimum number of ligatures should be used in suturing any wound to avoid as much postoperative pain as possible. It is impossible to tie off an artery which supplies bone; therefore, hemorrhage occurring in bone is controlled by pressure, such a procedure having very little to do with postoperative pain.

In some regions in the oral cavity it is impossible to use ligatures, on account of the location and the consistency of the tissue, as, for example, the gum tissue, hard palate, alveolar process, sockets, etc. In these tissues it is better to rely on compression by packs, cautery, and styptics. Producing compression by the pack is an excellent means for controlling bleeding which has been caused by severance of the tissue by a sharp instrument, whereas the cautery may answer the purpose of both the knife and hemostatic in case a small vessel is severed or can not be reached by a ligature or pack.

The injury produced by the cautery causes a burning pain which may last for several hours. It is well, therefore, to employ block anesthesia before using the cautery. It must be remembered that cauterization covering a long period of time, using a low temperature, will produce pain which may last much longer than if a higher temperature is employed and allowed to remain in contact with the tissue for only a brief time. This means of cauterization does not produce as satisfactory hemostasis as the low heat cautery extending over a longer period of time.

Postoperative pain is caused in many instances by improper suturing, and this is a subject that greatly concerns us. The requirements of a suture are to hold the edges of the wound in apposition, and excessive traction must not be brought upon the tissue by the suture, for the reason that it not only tends to produce postoperative pain but causes inflammation and retards tissue repair.

For plastic operations on the face, the deeper structures should be carefully placed and sutured to retain their position, and if the incision in the skin has been properly outlined and made, it is a comparatively easy matter to obtain and retain perfect coaptation of the edges with the properly placed sutures, which will cause no after-pain, infection, and no large scar. Enough pressure should be exerted on the tissue by the sutures to hold the edges of the skin in apposition. If this is done, it will tend to eliminate infection, postoperative pain, and an unsightly scar. When suturing muscle, fat or connective tissue, it is essential to place the sutures deeply to avoid the formation of air spaces. Care should be exercised not to suture too tightly, but to obtain coaptation and prevent tension of the tissues which would result in considerable postoperative pain.

Postoperative pain may be caused by the reaction of the tissue itself. As pointed out previously, most wounds connected with operations performed within the oral cavity become infected; therefore, more postoperative pain will be experienced in this region than in other regions of the body where a similar amount of incising has been done. It is almost impossible to eliminate wound contamination following an oral operation. We must, however, guard against infection and complications as much as possible. Oral operations are performed upon the tissue which harbor many bacteria, and the proper preparation of the tissue before incising it will in a great measure reduce the number of the bacteria, although it is absolutely impossible to sterilize it thoroughly.

After the incision is made, the problem which confronts the operator is to prevent the saliva and mucus and other debris, located in the oral cavity, from entering the operative field. The electric knife for making the incision has a wonderful advantage over the scalpel, as it makes a clean-cut incision. The electric knife not only tends to control the postoperative hemorrhage, but it comes in immediate contact with bacteria, destroying them and leaving an aseptic charred surface of tissue. The use of the electric knife and the production of the eschar cause postoperative pain which may last for several hours following the operation, and in these cases deep block anesthesia can be employed. By injecting the correct solution, anesthesia of the part can be maintained for several hours, which will tend to eliminate postoperative pain following such a surgical procedure. In case the primary injection is not sufficient to prevent the pain resulting from the removal of a malignant growth, which may continue for a few days, blocking can be made by using a solution which contains both procain and quinin and urea. The electric cautery method is of exceptional value for the destruction of growths which may be located on the gums and hard palate. In some regions sutures or ligatures can not be conveniently employed. To control hemorrhage, pressure, as produced by gauze packs, wax, plugs, etc., is employed. It serves not only to close tissue spaces against infection, but also provides ample drainage. When a gauze pack is employed for the purpose of reducing or limiting infection, one should use sterile gauze saturated with an antiseptic, germicide, and anodyne solution. If little hemorrhage is present, and medication is desired to prevent postoperative pain, gauze is not used, but other methods are employed, such as an obtundent paste. (See page 837, "Methods and Drugs Employed in the Treatment of Postoperative Pain.")

Gauze, which is medicated with an antiseptic or germicide placed in an open wound, excites reaction in the tissues before producing inflammation with the production of fibrin which has a tendency to hold the pack in place and to serve as a relatively aseptic dressing. In case active suppuration takes place in the wound, a medicated gauze pack will act as a foreign body and will greatly increase the pain. If this is the case, the pack should be removed. The part should then be carefully irrigated and packed with fresh gauze which has been medicated with the proper drug. Many times the pack is placed in the wound under pressure, causing the patient to suffer considerably, due to the pressure exerted by the pack on the sensory nerves in the inflamed tissue. A gauze pack located in the oral cavity should not be left in place longer than twenty-four hours without redressing, and if it is left longer it will in most cases cause unnecessary discomfort to the patient. In many cases a germicidal antiseptic paste is preferable to a gauze pack.

Secretions that form in the wound may cause considerable after-pain on account of the increasing pressure exerted by them, but this cause can be easily overcome by free drainage. In draining a wound it is not necessary to place the drain at the lowest point to procure ample drainage because the soft tissues which form the walls of the wound are in contact and assist materially in draining the parts. This feature is of exceptional value to the oral surgeon, inasmuch as in many instances it may be difficult to drain a wound at its most dependent part on account of the location of the operation.

Operations on the upper jaw which involve the mucous membrane should be drained intraorally, which not only reduces the amount of postoperative pain which would be caused if the wound were drained externally through the skin, but it will obviate an unsightly scar. This technic holds good for operations on the floor of the mouth or upon the lower jaw.

The fourth factor in the production of postoperative pain, as given on page 832, will now be considered. Postoperative complications following an oral operation may occur in the immediate region of the operation, or they may be remote, causing such discomfort as headache, disturbances of the wound during the act of coughing or vomiting, or even during respiration or deglutition pain may be produced. Pain located within the operative area, or within the area in which the deep injection has been made, may be manifested as the result of pressure, swelling of the tissue due to edema, false ankylosis, for example, following an improperly made inferior dentolingual injection, or following the surgical removal of an impacted third molar or the reduction of a fracture. If the operation involves considerable tissue, headache of some degree is generally present. If the operation is an oral one and involves considerable tissue, the patient will feel pain during deglutition to such an extent that solid food can not be taken; hence a liquid diet is recommended. However, if extreme swelling of the soft parts in the region of the pharynx is present, and the patient suffers considerably during deglutition, he should be given liquid nourishment through a tube or fed per rectum. It is only in the major cases that rectal feeding is employed. In some cases the stomach tube can be employed to advantage. Vomiting very seldom occurs following block anesthesia; in fact, the operator will seldom see such a condition; whereas vomiting is more likely to occur following the administration of a general anesthetic. To eliminate coughing, which may cause pain, considerable care should be exercised not to allow any irritating substance to come in contact with the respiratory passage, as coughing is dependent upon tracheal irritation and can be largely controlled by preventing such irritation. The operator should never allow blood or mucus from the operative field to pass down the patient's larynx or pharynx. If a patient is being operated upon under block anesthesia, respiratory reflexes are present at all times, whereas if a general anesthetic is employed, the respiratory reflexes are absent. Bloody mucus and infected material are responsible in many instances for irritation of the trachea which causes severe coughing and postoperative pain. Tracheal irritation not infrequently follows general anesthesia. Operating under local anesthesia from this standpoint alone, is far superior to that of general anesthesia. After-pain following surgical operation and the use of local anesthesia in its various branches, particularly by the deep block method, opens a broad and fascinating field, to determine definitely its etiology in obscure cases. When postoperative pain follows an operation performed under local anesthesia, its cause can not always be attributed to the anesthetic, but to many factors which have already been enumerated. The duration of anesthesia is a factor which is under the control of the operator. For example, an injection of a 2 per cent procain suprarenin (1/250 per cent) Ringer solution will produce and maintain anesthesia of the part from forty-five minutes to an hour, and partial anesthesia will last one hour longer. At the expiration of this time the pain that has been caused by the incising of the wound has in most cases ceased, and if the patient should experience after-pain, it is no doubt due to some of the factors mentioned. *The greatest single factor in the causation of postoperative pain is injecting a solution that is not isotonic. Only a sterile, physiologic, isotonic Ringer solution should be employed as the local anesthetic vehicle.* The anesthetic will control the pain that is due to the actual incising or that which is produced by sutures and ligatures. However, as soon as the local anesthetic action has passed, the patient may feel pain from trauma, incising, curettement, extraction, etc. Such operations may cause painful deglutition, pain during coughing or on movements of the jaw. Postoperative pain can be controlled in many instances by anesthetizing the tissues for an indefinite period with a weak solution of quinin and urea hydrochlorid, and this method is of value if it is properly used. In the past, however, too much has been expected of it, and as a result some operators have condemned its use. Some writers have claimed that quinin is the cause of postoperative pain due to secondary disturbances which it causes; but research work, which has been carried on by Hertzler and others, has proved this to be erroneous. Hertzler states that quinin and urea anesthesia is of exceptional value if the electric knife is used, or the tissue is to be cauterized, from the fact that anesthesia lasts a considerable length of time, and the large cauterized area may run a complete course without any postoperative pain whatsoever.

Quinin and urea hydrochlorid may be used many times for blocking at a distance from the field of operation, if the anatomical arrangement is such that this can be done, and such blocking will be found advantageous for controlling postoperative pain. For the removal of new growths, such as an epulis or cyst, procain suprarenin Ringer solution is used for blocking, in order to eliminate the pain incident to the operation, while in many instances quinin and urea hydrochlorid can be injected in contact with the nerve trunk at a distant point, and maintain anesthesia of the part for a considerable time, which will control postoperative pain. The operator should not lose sight of the fact that the control of postoperative pain is a very broad and important subject, and that each type of patient as well as the operation must be carefully studied and worked out in a concrete manner.

METHODS AND DRUGS EMPLOYED IN THE TREATMENT OF POSTOPERATIVE PAIN

In the event that postoperative pain follows block anesthesia, or is a result of the operation itself, or the combination of both factors, it is the operator's duty to combat such a condition to give his patient relief and rest. If postoperative pain is present, it may be the result of any one of the factors already mentioned on page 828, and must be treated. *Some operators believe that postoperative pain is always due to injecting the solution into or near the nerve trunk, but the author desires to emphasize the fact that such is not the case.* It is true some irritation may follow the injecting of a perfect solution, and some patients may feel a little soreness, even if the best technic has been followed.

The treatment of postoperative pain consists of ascertaining its cause, if possible, and the use of the following methods and drugs in combating it:

1. Treatment by compress. Usually a cold compress gives greater relief than one of heat. This should be applied to the part and changed frequently.

2. After the extraction of an infected tooth, or the surgical removal of a tooth complicated with a granuloma, curette and syringe the cavity with an efficient antiseptic solution.

3. If the anesthetic solution contains a too high percentage of the vasoconstricting agent, which produces profound anemia of the part and increases the danger of infection, employ hot packs.

4. By the use of a local obtundent paste or compound applied to the cavity or socket. It may be applied on gauze or the cavity can be filled with it to protect the exposed, lacerated, sensory nerve endings from the oral fluids, air, etc.

The following formula is an excellent one for relieving pain following laceration of tissues and the exposure of the alveolar process after extraction or the surgical removal of teeth:

(Author's formula)

℞	Anesthesin	gr. xxv
	Chloretone	gr. xxv
	Menthol	gr. v
	Oil of wintergreen	♏ v
	White vaseline (sterilized)	℥ i
	Misce.	

Sig.: Fill socket or bone cavity with compound; apply with syringe and large curved tube.

The compound which is in contact with the alveolar process or bone gradually melts, and the anesthesin exerts a prolonged anesthetic action; the chloretone is an antiseptic as well as an anesthetic. Menthol is an anesthetic, antiseptic, and cooling to the tissues. The wintergreen is an antiseptic, stimulant and anodyne to exposed sensory nerves. The vehicle vaseline gives it body and keeps the drugs from being too rapidly absorbed. This preparation may be left in the socket, as it is absorbed in most cases in forty-eight hours, thus achieving its therapeutic effect, and also keeps the debris out of the wound. No pressure need be exerted upon the wounded tissue, as is the case many times when gauze packing is employed.

This compound gives the patient almost immediate relief if pain is due to the exposure of sensory nerve endings, the result of a denuded alveolar socket, bone, or tissue which has been traumatized. The prolonged anesthetic effect will give the patient relief for hours where otherwise there might be considerable suffering. This compound does not interfere with tissue repair and does not exert pressure, so it is unnecessary to remove it.

Another compound which is very efficient is that of dentalone, which has the following formula and contains 30 per cent of chloretone:

℞	Oil of birch	minims	12
	Oil of cinnamon	"	50
	Oil of cloves	"	300
	Chloretone	"	175
	Misce.		

Sig.: Apply to socket or operative part on gauze. In most cases the dressing should be changed within 48 hours.

Another method of dressing a socket is as follows: Pack the tooth socket with a small piece of iodoform gauze which has been saturated with the above compound. Then a second piece of iodoform gauze is saturated with dichloramin-T, 5 per cent, and placed on top of the first piece, which assists in preventing the escape of the first compound employed, and also aids materially in preventing the ingress of saliva.

Another local obtundent which is employed is euroform paste. It is used in the same manner as the author's formula above described. Euroform paste consists of the following:

(Formula by Dr. J. P. Buckley)

℞	Orthoform	ʒ i
	Petronol	ʒ iiss
	White petrolatum	ʒ iiss
	Europhen	ʒ iss
	Misce.	

Sig.: Saturate a small piece of plain gauze with the paste and gently pack into the painful socket. Remove the gauze at the end of 24 hours and reapply, if necessary.

5. Postoperative pain may also be treated by the use of some local anesthetic powder such as the following:

Orthoform New.—This compound is a local anesthetic which resembles cocain in its local action, but is not so toxic and does not penetrate the tissues on account of its insolubility. It is somewhat antiseptic and practically nontoxic in the usual doses. It is beneficial for the relief of postoperative pain when applied to denuded surfaces, and has been used considerably in the treatment of after-pain caused from the extraction of teeth.

(For further description, see orthoform "new" page 244.)

A convenient method of employing orthoform powder is to place it in the tooth socket or wound, and protect it by loosely packing cotton over it, so that it will not be washed away by the fluids of the mouth. This method of application has been recommended by Dr. Henahan.

Anesthesin and Subcutin.—Both of these compounds are synthetically prepared and are merely modifications of orthoform. They are of value when applied locally in powder form for the relief of pain following rhinological and laryngeal infections. They are also valuable for sedative topical applications. They can be applied as a dusting powder, pure or diluted, or in the form of an ointment. (For further description of these drugs and their uses, see pages 220 and 251.)

6. Dr. LeRoy Miner, of Boston, recommends the application of guaiacol-glycerin in equal parts. This compound is very valuable in the prevention of after-pain. Gauze is saturated and loosely packed into the socket or wound. Guaiacol is both antiseptic and germicidal.

7. By dressing the wound with pure procain powder which can be applied as described above under No. 5.

8. By dressing the wound with Tribel's solution which is as follows:

℞	Chloral hydrate	ʒ iv
	Camphor	ʒ ii
	Procain	ʒ i

Misce.

Sig.: Apply to wound upon gauze which has been saturated.

DRUGS ADMINISTERED INTERNALLY TO COMBAT POSTOPERATIVE PAIN

9. Several drugs can be employed very effectively in cases in which they are indicated to combat postoperative pain resulting from surgical procedures.

Bromural (alpha-monobrom-isovaleryl-urea; $C_6H_{11}H_2O_2Br$).—This is a nerve sedative and ranks in action between the bromides and morphin, and it is claimed that in a large dose it will produce sleep without markedly affecting the circulation or respiration. It is also contended that all action resulting from this drug will cease after three to five hours. It has been considered of value, and has been recommended in the treatment of postoperative discomfort and pain, but bromural does not have the power to eliminate postoperative pain to any considerable extent, because it does not produce such intense action as morphin. However, it is a nerve sedative and will relieve pain if it is not severe in character. As a nerve sedative it is given in 5-grain tablets, three times daily. If it is desired to produce sleep it should be administered in 10-grain doses, preferably at bed time, and may be repeated if necessary, in three or four hours. Following an oral operation patients may be given a prescription for bromural tablets, with instructions to take 10 grains immediately, and to repeat in three or four hours if they experience pain. This drug is dispensed in 5-grain tablets which can be readily dissolved in hot water for immediate effect. Bromural is not a habit-forming drug, such as morphin, and it can be readily dispensed by the dentist without conforming to the Harrison Act. It is also a valuable drug in preparing a hypersensitive or nervous patient for an oral or dental operation.

Validol.—Validol is known chemically as methylvaleriate, having a chemical formula of $CH_3CH_2CH_2COO.C_{10}H_{19}$. It is the menthyl ester of valeric acid with 30 per cent of free menthol. The action of validol is that of a nerve sedative and antispasmodic, and it is recommended especially for nervous and hysterical individuals. It is used in the treatment of hysteria and other neuroses, especially those of the circulatory, digestive, and central nervous systems. It has been lauded in the prevention and treatment of seasickness. It can be used with gratifying results as a preliminary agent to combat fear and excitement, and is also employed with very good results following an oral operation, in the treatment of nervousness or slight after-pain. Validol is a crystal, clear, colorless liquid, of the consistency of glycerin, having a mild and pleasant odor, distinct from either that of menthol or valerian, and a refreshing, cool and very faintly bitter taste, insoluble in water, but readily soluble in alcohol, ether, chloroform, and oils. It is administered by adding seven or eight minims to a small amount of water, or a more efficient and agreeable method, which has been suggested by Dr. C. Edmund Kells, of New Orleans, is to place seven or eight minims upon a block of sugar. This is a very convenient way of administering it, inasmuch as it is insoluble in water and is very pleasant for the patient to take in this way. Validol has the effect of both valerian and menthol.

Camphorated Validol.—This is a preparation of 10 per cent camphor in validol, and has the combined action of both validol and camphor. The action of validol has been mentioned above. The action of camphor is to stimulate the central nervous system, especially the medullary center, and the circulation. Large doses of camphor improve the pulse in impending cardiac collapse, probably by cardiac stimulation. For this reason, it is used as a circulatory and respiratory stimulant in case of collapse, syncope, heart failure, etc. The combining of these two drugs makes an excellent preparation, either as a preliminary or postoperative sedative, and antihysteric, in the treatment of postoperative complications and neuroses. This compound is used more as a stimulant in the treatment of syncope. The adult dose is ten minims, which may be placed upon a block of sugar and taken internally.

Bromides.—These salts are freely soluble in water, salty to the taste, and slightly irritating to the mucous membrane, if applied in the pure state. The most important compounds are potassium, sodium and ammonium bromides. These compounds form colorless or white crystals, or a granular powder, and are soluble in 1.5 parts of water. These salts have the power to reduce irritability of the centers of the cerebrum without producing a state of anesthesia. The bromides are employed in any condition where there is cerebral or nervous excitement, such as postoperative pain, headache, injury to the brain, meningitis, hysteria; also in epilepsy and other convulsive disorders. These drugs are of some value in the treatment of nervous disturbances and postoperative pain following an oral operation, if the pain is not too severe in character. The bromides produce a much lighter action than does bromural or morphin. Therefore, if the patient is suffering considerable pain this drug will not afford much relief. Sodium bromid is usually selected, because it does not produce as much irritation as the ammonium or potassium bromid. It is administered in dilute aqueous solutions, and the dosage is 15 grains, repeated in an hour, if necessary.

Chloral Hydrate.—This is a very efficient drug in the treatment of postoperative pain as well as to reduce the hypersensitiveness of the pa-

[illegible] crystalline solid, and occurs [illegible] aromatic penetrating odor, and [illegible] system producing a feel- [illegible] and respiration are [illegible] the reflexes are not abolished. [illegible] caused by the administration [illegible] individuals possessing a weak- [illegible] given with satisfaction in [illegible] conjunction with the bro- [illegible] among many of being a very dan- [illegible] doses. The average dose is 10 [illegible] cracked ice. The dose may be [illegible] the condition of the pulse and respiration [illegible] doses are given. It is also an important [illegible] patient for an operation, [illegible] minutes before operating.

[illegible]in [illegible] compound and a derivative of pyramidon [illegible] used as an analgesic and nerve sedative in [illegible] trigeminal neuralgia, headache, etc.

[illegible]midon [illegible] chemically as dimethylaminoantipy- [illegible] reduction of nitroso-antipyrine to amino- [illegible] methyl chlorid or iodid. It forms small, [illegible] soluble in 11 parts of cold water, and [illegible] It acts as an antipyretic and [illegible] from harmful influences to [illegible] combating postoperative pain [illegible] most conveniently administered [illegible] to 0.4 gm. A single dose usually

[illegible] [illegible] chemically as acidum acetylsalicylicum, with [illegible] This drug is a valuable anti- [illegible] valuable in the [illegible] It is very popular in the treat- [illegible] postoperative pain, etc. It may be given in [illegible] If [illegible] prescribed as a powder, [illegible] sweetened water, or by placing it [illegible] water. It [illegible] best given in tablet [illegible] grains [illegible] grains [illegible]. Aspirin acts like salicylic [illegible] less disturbing to the stomach. [illegible] when postoperative pain is expected, the [illegible] tablets with instructions to take every two [illegible] results are obtained by combining aspirin, 5 grains [illegible] grains [illegible] of pyramidon.

Trional.—This drug is known chemically as diethylsulphonemethylethylmethane, and is hypnotic. In ordinary cases it produces sleep in about an hour after the drug has been given. It is used mostly as a hypnotic in insomnia, but is of little use when the insomnia is accompanied by pain. Trional closely resembles sulphonal, but the former is more soluble than the latter. The average dose is 15 grains and is usually administered in the form of a powder, and in most cases is given two or three hours before retiring.

Morphin.—Morphin is employed in difficult cases, as a preliminary measure, in allaying fear and excitement, also in some difficult cases to control the pain resulting from operative procedures. We are not often compelled to use morphin, but there are cases in which this drug is indicated and can be used to advantage. It is a habit-forming drug, and the operator must conform to the Harrison Act when prescribing it. He should use due care in prescribing it so he cannot be held responsible for starting the patient with the morphin habit. Morphin is the alkaloid of opium and has the chemical formula of $C_{17}H_{19}NO_3H_2O$. It has no local action and fortunately the drug is little needed in dental practice, with the exception of treating patients with postoperative pain following some extensive oral operation. Morphin has three actions, *first*, a specific central analgesic action; *second*, a depressing action on the entire central nervous system; *third*, a constipating effect resulting from the combination of central and local actions. The systemic action of morphin is greatly dependent upon the dose used. The smallest doses which produce therapeutic effects are followed by the relief of pain; and somewhat larger doses may cause definite cerebral depression, leading to more or less profound and prolonged sleep. This drug is employed chiefly as an analgesic in conditions of severe acute pain. In surgical conditions, in which the alleviation of pain may obscure the course of the disease and lead to the unwarranted postponement of an operation, morphin should not be used, or only in very small doses, and with circumspection. It should not be employed when any satisfactory relief can be obtained by the use of other drugs. The dosage of this drug is as follows: $\frac{1}{6}$ to $\frac{1}{4}$ grain, or in combination with scopolamin $\frac{1}{150}$ of a grain. The combination of these two drugs is very useful as a preliminary measure and may be administered hypodermatically thirty minutes before the operation.

General Considerations.—Morphin and scopolamin may be used not only for deep nerve block injections in highly nervous individuals for the treatment of tic douloureux, but they are of exceptional value prior to the time of administering a general anesthetic. The above named sedative and hypnotic drugs, when properly administered in therapeutic doses, are of great value to the operator in allaying postoperative pain which is certain to accompany some of his operations, and will carry the patient over a number of painful hours following an operation, into perfect rest and comfort. It is not necessary in all cases following deep block injections to administer any of the sedatives or hypnotics mentioned, but they are needed many times for certain individuals in the course of practice, and their employment is very much appreciated by the patient. The important links in the great chain known as anoci-association are as follows:

1. Proper preoperative environment.
2. Preoperative administration of an anodyne or hypnotic.
3. Block anesthesia and general anesthesia.
4. Most careful handling of the tissues during the operation.
5. The postoperative administration of anodynes or hypnotics to relieve and combat postoperative pain.

BROKEN NEEDLES

It is true, the best of operators will meet with accidents occasionally, but if platino-iridium needles are employed and due care is taken while making a deep injection, so as not to insert the needle up to or close to the hub, little or no difficulty will be experienced. The operator should carefully select his needles and see that they are of the correct diameter and length, and then use them properly, which will usually save him considerable time and annoyance in removing a fragment which has been broken in the tissues. The use of needles for the deep block method is quite different from using short needles for peridental, submucous and subperiosteal methods as practiced in the past. With these latter named methods, should a needle be broken, its location is superficial and in such a position that in most instances the broken fragment can be easily removed. On the other hand, if a deep injection is being made and the needle should break, the end of the needle may be covered by soft tissue which conceals it from view, making it extremely difficult to locate.

The breaking of needles has been quite a common occurrence while making the following injections, and they are named in the order of their frequency:

1. Inferior dentolingual injection.
2. Posterior superior dental injection.
3. Blocking the second division of the fifth nerve by the intraoral method.
4. Long buccal injection.

A needle may break while making other deep block injections, but not as frequently as in making the above named injections, for the reason that the location does not place the needle under any severe lateral strain. The breaking of a needle in most cases is due to unfamiliarity with the technic, and causing severe strain upon the needle. The writer does not wish to leave the impression that needles never break in the hands of those who are skilled in the technic, for such is not the case. The best operators break needles occasionally, but the constant breaking of them in the tissues is wholly uncalled for and can be greatly reduced by technical skill.

There is no question but that a platino-iridium needle is by far the safest one to use, and is the cheapest in the end, as it will not rust, may be sterilized in the flame, and can be used repeatedly. The author does not recommend the use of steel needles, but if the operator insists on their use, he should discard them after using only a few times, as after they are used and subjected to the antiseptic solution or boiling, they rust very quickly, which greatly weakens them, causing them to break easily when strain is placed upon them. A very fine steel needle is certainly dangerous after it has been in use for several weeks, as its strength is greatly reduced by rust which accumulates in its lumen. Most needles break at the joint, which is the weakest point. A needle guard such as illustrated in Fig. 186 not only strengthens the needle at the soldered joint, but in addition, prevents the needle from being inserted to the hub. *During a deep block injection the needle should never be inserted into the tissues to the hub.* (See Fig. 398.)

While inserting the needle into the tissue of a hypersensitive or nervous patient, the operator should always be on his guard and prevent the patient from moving the head quickly which may result in an accident. Far more needles have been broken in making the inferior dentolingual injection than any other. Should such an accident occur, the operator should not palpate the soft tissues in the region of the needle, as this will force the needle deeper into the tissue. The broken fragment should always be removed, and the patient should never be dismissed with a needle embedded in the tissue.

TECHNIC FOR REMOVING BROKEN NEEDLES

Before removing a broken fragment from the tissues, the parts should be thoroughly anesthetized, which may require a second block injection into the region. When the needle is broken beneath the surface of the tissue, if possible, locate the point of insertion, which is usually visible. If this can be located, a small perpendicular incision is made through the point of puncture, and the needle felt with the lancet. If possible, expose the end of the needle, after which the broken fragment may be grasped with a small pair of artery forceps, using great care not to force the needle further into the tissue. If the end of the broken fragment cannot be located, it is always advisable to make an x-ray plate but before doing this, insert a second needle as near the broken fragment as possible, and leave it in position while the x-ray is being taken. The comparison of the broken fragment with the needle which has been inserted will in most cases be an excellent guide to show how and where to make the incision. (See technic below.)

A magnet, such as is used by ophthalmologists for removing steel from the eye, may also be of value if the broken needle is steel. Such a magnet is equipped with a pointed extension which can be inserted into the mouth at the point where the incision is made, and when the tip of the extension comes in contact with the needle it will in most cases withdraw it from the tissue. However, the magnet method has its limitations, as the needle may be located in certain parts of the mouth which makes it impossible to bring the instrument in the region of the incision, and should tissue separate the end of the magnet from the needle, it will have no effect. Broken needles that are left in the tissue for a considerable length of time have a tendency to change their location. For instance, a needle which has been broken in attempting to make an inferior dentolingual injection, its point is located distally, while the broken end is toward the surface, and the movement of the patient's jaws will have a tendency to move the needle backward because of the pointed end.

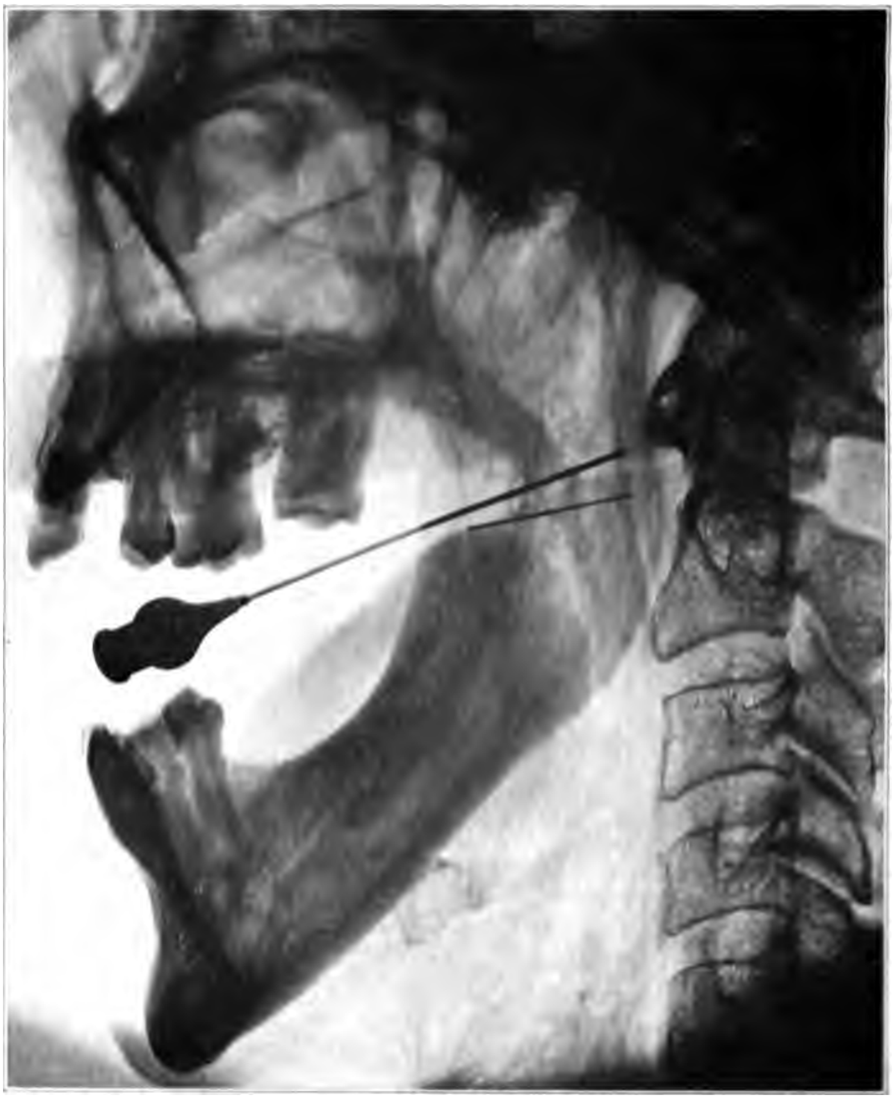

Fig. 567.—X-ray of right lower jaw showing broken needle medial to ascending ramus in region of inferior dental lingual nerves. Note the inferior position of broken fragment to second needle. Lateral exposure. (See Fig. 568.)

Technic for Locating Broken Needle.—The writer employs what he considers an efficient method for locating a broken needle through the medium of the x-ray. Insert a needle such as number 2 (see Fig. 177) mounted on the extension hub used for tonsillectomy (see Fig. 208) in the tissues as near the broken fragment as possible, being careful not to force the broken needle further into the tissues. Two x-ray plates should be made. The first exposure

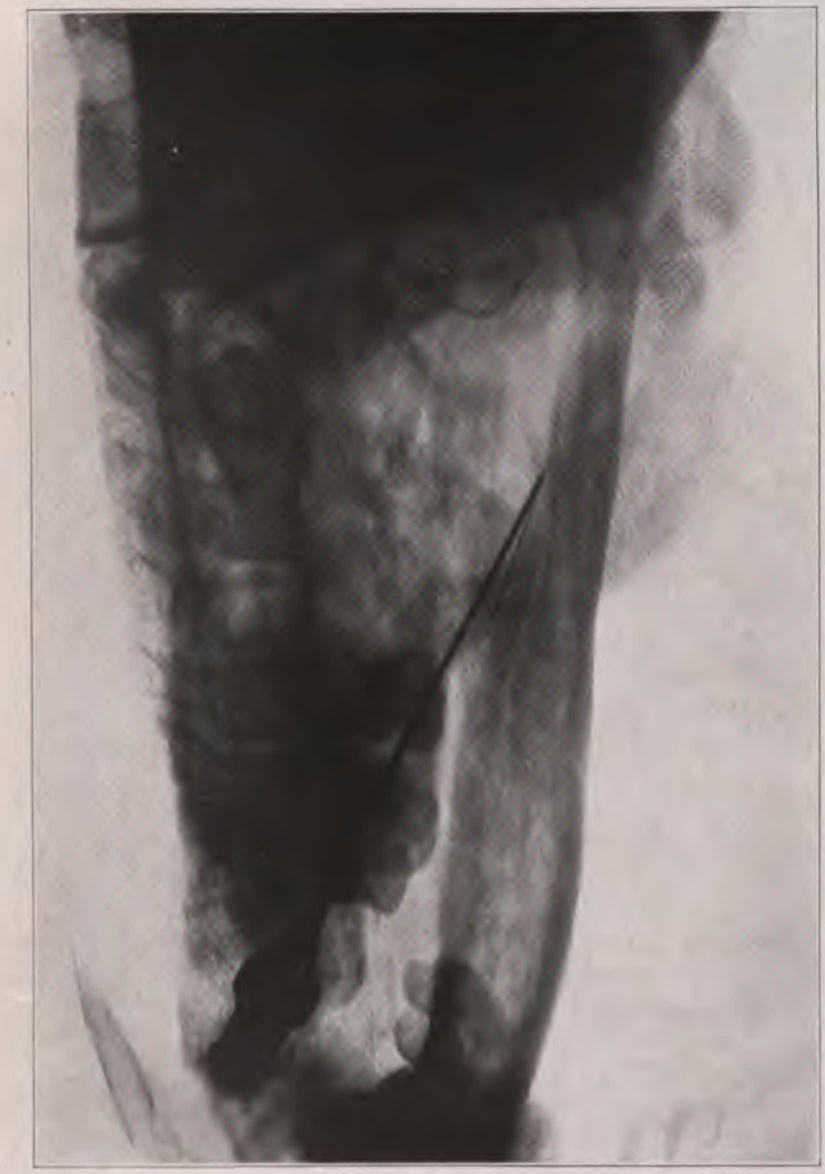

Fig. 568.—X-ray of right lower jaw showing broken needle medial to ascending ramus in region of inferior dental lingual nerves. Note the lateral position of broken fragment to second needle. Exposure made from above downward. (See Fig. 567.)

is from a lateral position (see Fig. 567) which will show the superior inferior relation of broken fragment to second needle. The second exposure is made from above downward which shows the mediolateral position (see Fig. 568). By the aid of these two x-ray plates the operator can easily locate the position of the broken needle. An incision is made along the second needle to the proper depth and then into the region of broken needle in accordance to x-ray findings, after which the fragment is removed with artery forceps. This method can also be used for locating and removing foreign bodies from other parts of the body.

HEMATOMA

Definition.--A hematoma is a tumor containing blood, or it can be defined in the sense of block anesthesia as that of a circumscribed area of tissue containing extravasated blood.

This is a condition which occurs occasionally following deep block injections, especially the posterior superior dental injection and the infraorbital injection. A hematoma is produced by inserting the needle into a small blood vessel and usually occurs when the needle is forced, by inserting it into a foramen. It is difficult to insert the needle into a vein or artery when the structures are surrounded by loose connective tissue, and a needle with a short bevel is employed, as there is a tendency for the blood vessel to escape the end of the needle. However, when the needle is inserted into the foramen it is a different proposition because here the blood vessels are bound to the periosteum by connective tissue and can not escape the needle point.

Another common cause of producing a hematoma is from the use of a curved needle, as with a needle of this character it is impossible for the operator to know the exact location of the point.

Symptoms and Treatment of Hematoma.—If a small vein or artery is punctured by advancing the needle into the tissue, a very rapid extravasation of blood will take place in the loose connective tissue surrounding the blood vessel, and the amount and rapidity of the swelling are dependent upon the location of the hematoma. The skin and other tissues which cover the superior maxillary bone in this region will protrude considerably, and such a condition many times has frightened the patient as well as the operator.

No complications are likely to ensue, provided the operator has employed a sterile syringe, needle and solution. The extravasated blood is enclosed within the tissue and can not escape upon the surface. The greatest difficulty the operator meets is that it is very hard for him to explain to his patient just how this condition was caused. It is the best policy to explain to the patient that an extravasation of blood occurred at the point of injection, and that there is no cause for alarm, as the swelling will disappear in a few days. In most cases the skin will assume a darkened or a cyanosed condition, the extent of which depends upon the amount of extravasated blood and the depth it is located from the skin surface. The discoloration of the skin is due to the breaking down of the erythrocytes with the liberation of iron. In most cases the patient does not experience pain, but if such should be the case administer bromural, aspirin or pyramidon, and apply cold packs to the part; massaging and electrical treatment may also be employed for stimulating absorption. The extravasated blood will be absorbed slowly and the swelling will disappear in most cases in three or four days. Should the operator encounter one of these cases, he should assure his patient that no serious complications will result, as otherwise considerable worry and anxiety may be caused.

CHAPTER XXXVI

SYNCOPE, SHOCK AND COLLAPSE

Shock is a condition of general depression always accompanied by a fall in blood pressure which is caused by exhaustion of the vasomotor center. This fall in blood pressure is observed at the onset of shock and is the key in determining the degree of depression. The accompaniments are a rapid, feeble pulse and shallow respiration while the patient is in shock. The above symptoms are rapidly followed by pronounced lessening of all cutaneous reflexes, cold, clammy skin, and the patient in most cases complains of being cold, due to a rapid lowering of body temperature. A cold perspiration rapidly appears, especially on the forehead and hands. The patient is in a very quiet state of mind, seldom restless, on account of the extreme depression. He may be conscious or just bordering upon a semiconscious state or wholly unconscious. When a patient is in a state of shock he usually experiences no discomfort or pain; he wishes to remain quiet on account of his extreme weakness. The pulse in most cases is soft and irregular, the pupils dilated, eyes dull and expressionless, and at the onset the respiration may be sighing, but later followed by shallow and feeble respiratory movements.

Two varieties of shock are described by Moullin: ***First***, one which is characterized by extreme depression, and the *second*, which is very much more rare, is accompanied by excitement. In the ordinary form of shock caused by extreme depression the patient wishes to remain as quiet as possible. He will lie with his eyelids half open; he is conscious and will answer questions in most cases. As there is more or less impairment of speech, the patient speaks slowly and softly and seems to pay no attention to his surroundings. Considerable muscular relaxation is present, and when an arm is raised, it will drop lifelessly, offering no muscular resistance. The patient loses his normal expression and instead a ghastly one is present. He is extremely pale and anemic. The pulse is increased in frequency, usually irregular, and soft in character. A wide variation in pulse pressure seems to exist; that is, when the pulse is taken it seems as though the artery entirely collapses with each beat of the heart. If there be a marked degree of shock, the sphincter ani is usually relaxed. If the patient is not in severe shock, he is capable of interpreting the sense of pain. However, if the shock is pronounced, he is entirely oblivious of any pain that might be inflicted during any movement, as in the case of an accident or operation.

Shock varies in depth, and its intensity may be of a light form, such as fainting, which rapidly passes away, or may be of an intense character, which will gradually terminate in death, or it may prove instantaneously fatal.

The second form of shock, which is rather rare, is characterized by excitement, and in most cases is marked by a very gradual onset. The pulse in this form of shock is very rapid, thready and weak. The patient becomes excited and talks incoherently; he tosses about in bed, throwing his arms and legs in all directions regardless of pain from which he is suffering. In most instances this condition is rapidly followed by an extreme fall in blood pressure, collapse and death. (See Chapter XIII; Indications and Contraindications and Precautions Necessary While Operating under Block Anesthesia.)

Causes of Syncope, Collapse and Shock.—The general depression which prevails in syncope, shock and collapse is due to an overstimulation of the afferent nerves and nerve centers, rapidly accompanied by a fall in blood pressure. The degree of shock is dependent upon the amount and intensity of the afferent stimulation and the fall in blood pressure. Syncope and shock can be induced in a number of different ways, but here we will discuss the most important, which are, *first*, surgical manipulation; *second*, psychic disturbances, and *third*, shock due to an anesthetic or other agent.

Syncope and Shock Caused by Surgical Procedures.—Every precaution should be employed by the oral surgeon or dentist to avoid shock during a surgical operation. The traumatization or laceration of tissue which has not been properly anesthetized either by a local anesthetic or by anesthetizing the patient, may produce shock. Crile in his epoch-making classical researches has proved to the surgical world that the anesthetization of the patient merely by a general anesthetic does not by any means place him in a state which renders him immune to surgical shock produced by an operation, but in order to avoid shock it is necessary to employ the block method in conjunction with general anesthesia. The nerves supplying the parts are blocked with a local anesthetic which prevents the afferent sensory impulses from reaching the brain. When a local anesthetic is employed to block the operative field and is used in conjunction with a general anesthetic, combined with the proper preoperative and postoperative methods, the condition is known as anoci-association. It is more difficult to carry out the principles of anoci-association, as laid down by Crile, in the practice of oral surgery and dentistry than in general surgery, inasmuch as the operative field and structures involved in general surgery are different from those involved in oral surgery. Nevertheless, an oral surgeon can apply the principles of anociassociation to a considerable degree. In order to make the chain complete by this method, it is essential that a general anesthetic be employed to eliminate the psychic effect produced upon the patient during the operation. A local anesthetic eliminates physical and not psychic pain, whereas a general anesthetic eliminates both. According to Crile, however, a general anesthetic does not prevent the afferent traumatic sensory impulses arising at the site of operation from traveling over the afferent nerves and registering detri-

mental effects upon the brain of the patient. (See Fig.
the latter detrimental factor, block anesthesia is emplo
for the oral surgeon to administer a general anestheti
local anesthetic except in severe cases, for the tissues o
surgeon differ in character from those in the field of t
manipulation of the structures in the oral cavity does
turbance to the nervous system during an operation
such as appendicitis, the removal of tumors, gallston
The blocking of the sensory nerves supplying the ope
surgeon is, in most cases, sufficient, if the operator has
of his patient.

Let us take, for example, the removal of a badl
The operator should by no means begin his operation
plete, and during the surgical removal of the tooth, deli
be practiced at all times. The chiseling or burring of
incising and manipulating of the tissues should always
most delicate manner. Syncope and shock are in man
prolonged operation, which results not only from a
the patient is conscious, but from a general anesthetic
area has been blocked and the patient is subjected to a
mouth opened and packed with gauze for a consider
manipulation of tissue, the chiseling of bone, or other
necessary, may have a detrimental effect which may r
lapse. *The operator should handle the tissues carefull*
delicate performance of the technic is essential and
never be sacrificed for speed. These are steps in su
never be forgotten.

Keen states that a newborn babe can be operated
lip without an anesthetic, and such an operation is no
the only risk being hemorrhage. After the child is one
cal connections of the nervous system have been we
such an operation cannot be performed upon the infa
baby, as it is even more susceptible to shock than the a
in good health has the greatest resistance to shock, whil
age, possessing a senile heart with arteriosclerosis, acc
pressure, is in many cases susceptible to syncope and
that "A man is as old as his arteries," is applicable he
per se of the patient that increases the risk with an
age and condition of the circulatory system. An ind
age may possess a circulatory system found in a patie
tient of this character would not withstand an anesth
than one of advanced years. The vital powers of an
highest during the morning hours, and this is the princ
are operated upon in the early morning.

The vocation of the patient plays an important role in the production of shock. It is known that a professional or business man is far more susceptible to anesthesia, depression, syncope and shock than the laborer, such as the mechanic, farmer, motorman, policeman, etc. Athletes, as a rule, do not stand shock well. Patients who are anemic and cachectic stand surgical operations very poorly.

SYNCOPE AND COLLAPSE CAUSED FROM PSYCHIC SHOCK

Psychic shock is produced by abnormal impressions that are transmitted to the brain centers, bringing about a state of syncope. A local anesthetic eliminates physical pain, but it does not eliminate pyschic impressions. Therefore, the operator should be on his guard at all times, using diplomacy and tact, always obtaining the confidence of the patient before making the injection or before beginning to operate. Syncope or shock produced by psychic disturbances is caused by nervous impulses originating in the higher specialized centers of the cerebrum and exerting a detrimental action upon the highly specialized centers situated in the medulla. In a highly nervous individual, an operation performed under block anesthesia is not always free from pain; that is, the patient may be free from physical pain and suffer mental strain which may be more detrimental than the actual pain itself. The location of the operation which is to be performed under a local anesthetic is of great importance, inasmuch as the condition of the patient during operation must always be considered. For example, an operation upon the mastoid, a brain operation, the removal of a tumor from the oral cavity, or the resection of the superior maxillary bone, etc., under local anesthesia may prove detrimental to the patient, as he is conscious during the operation and the effect upon him may be very depressing. Extremely nervous patients readily show more depression than those who are not nervous, and it is in dealing with these patients that the operator must practice diplomacy and tact. The operator's assistants should be trained to instill confidence in the patient, and the conversation between the operator and assistant should be encouraging and assuring. A display of surgical instruments, hypodermic syringes and needles, should not be permitted, and the personnel in the operating room should be such as to instill confidence. (See Chapter XXII, The Patient.) The operator should remember that the patient is conscious and aware of everything that is being done, and any false move or hesitancy on the part of operator will be readily noticed by the patient; this is bound to register very detrimental effects. During the operation the operator should talk to his patient and assure him how nicely the operation is progressing.

Shock Caused by the Administration of a Local or General Anesthetic.—Shock produced by an anesthetic is dependent upon several factors, but here we will only mention the most important. *First,* by the administration of an overdose of the anesthetic agent; *second,* from susceptibility of the patient; *third,* from the toxicity of the general or local anesthetic employed; *fourth,* by restricted respiration; *fifth,* idiosyncrasy.

Shock produced by an overdose of a local or general anesthetic varies with the kind of anesthetic employed, with the individual and with the method of administration. *All secondary symptoms which follow the administration of either a local or general anesthetic are not dependent upon the amount of the local anesthetic injected or the amount of general anesthetic administered, but the toxicity and symptoms which they produce are dependent upon the rapidity of absorption, the susceptibility of the individual, the rapidity with which they are injected or administered and the general physical condition of the patient. What may be a toxic dose of a local or general anesthetic for one individual may not be for another, for all factors must be considered. Each factor should be weighed separately, and a definite conclusion reached concerning the amount to inject, and that amount should be based upon the physical condition of the patient. This also applies to other anesthetics, such as nitrous oxid-oxygen, ether, and chloroform. The question then resolves itself into concrete form, namely, that there is no so-called maximum dosage of either a local or general anesthetic which will apply to all individuals, but the maximum dosage for each individual case must be ascertained for that particular patient.* The reader is urged to refer to page 271 for suprarenin toxicity; to pages 227 and 283 for cocain toxicity; to pages 241 and 283 for procain toxicity; to page 281 for toxicity dependent upon five factors.

METHODS EMPLOYED TO AVOID SYNCOPE, SHOCK AND COLLAPSE

Physical Examination.—Before the injection of a local anesthetic solution, or the administration of a general anesthetic, it is always good practice to give the patient a physical examination. Many times a mere observation of the patient does not reveal pathological complications, and with these patients, if a local anesthetic is injected or a general anesthetic is given, trouble is liable to ensue. The writer does not wish to leave the impression that it is always essential to give a patient a thorough physical examination for the injection of a small quantity of a 2 per cent procain suprarenin Ringer solution, or for the administration of nitrous oxid-ogygen, for in most instances the operator will inject only a small amount of the local anesthetic solution in order to block the nerve branches. However, if a considerable amount of the solution is to be injected, and from the history obtained the general physical condition of the patient does not warrant it, a physical examination should be made. The author has often stated that nearly all patients who are able to visit the oral surgeon or dentist can have several nerve blocking injections made without any difficulty, provided the correct technic and solution are employed. The question has been asked a countless number of times just how much solution to inject, and the reply is that this depends upon the physical condition of the patient and the kind and quantity of local anesthetic solution injected. It is exceedingly difficult to say just how much solution can be injected, each individual case being a law unto itself. In many individuals it is highly advisable to make a physical examination of the heart and lungs and take the blood pressure. Any existing pathology of the heart and lungs can be detected readily through the medium of the stethoscope. (See italics above.)

Blood Pressure.—Blood pressure is a term employed to indicate the degree of pressure under which the blood exists while traversing the arteries. The condition of the blood pressure is readily revealed by the use of the sphygmomanometer. There is no instrument used in the practice of medicine, surgery and dentistry that is of greater value to the diagnostician and anesthetist than this appliance for taking blood pressure. Its value has now become so fully established that it needs no argument to show an intelligent physician or dentist the importance of this particular phase of a physical examination. Normal circulation is a vital function which is necessary in the maintenance of health, and it is a fact that the cardiovascular system is involved to a certain extent in the great majority of pathological conditions. It is self-evident that a knowledge of the condition of the circulatory apparatus is very important, not only in physical diagnosis, but in prognosis and in informing the operator of the exact status of his patient during the administration of a general anesthetic, or just how much solution he can safely inject or what general anesthetic should be administered. Many times the dentist

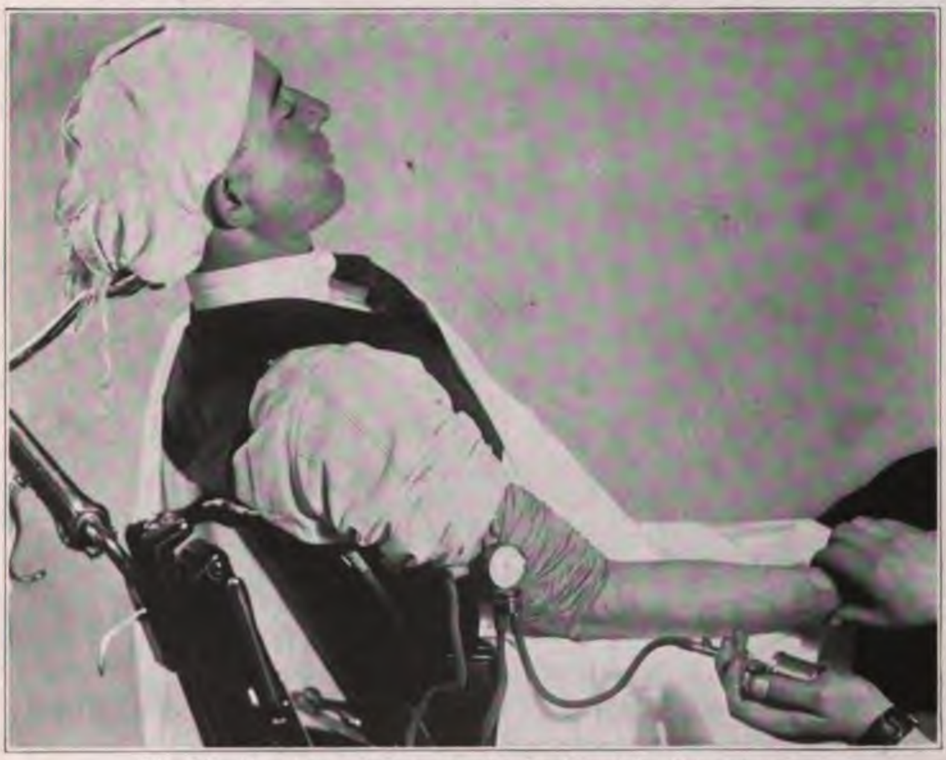

Fig. 569.—Use of the sphygmomanometer for determining blood pressure.

is confronted with patients who possess a pathological heart and a high blood pressure which is generally accompanied by arteriosclerosis. Many of them are advanced in years and present themselves to the oral surgeon or dentist for the removal of a number of infected teeth. If the examination discloses abnormalities of the circulatory apparatus, the operator is given a clue as to how much solution to inject safely, and he should by all means inject it with caution. Such patients must be given relief, and it is the operator's duty to utilize all of his skill in examining and in operating upon them. If he finds that the patient possesses a high blood pressure, then he knows only a limited amount of the anesthetic solution can be injected. If an overamount of suprarenin is injected, it will increase the blood pressure; whereas, on the other hand, when the suprarenin content is decreased, the procain toxicity is increased on account of a more rapid absorption. The operator must remember that suprarenin and nitrous oxid, both produce an increase in blood pressure. If cyanosis is produced by nitrous oxid the blood pressure is greatly raised. With patients possessing a high blood pressure, only a small amount of suprarenin should be slowly injected, and if nitrous oxid is administered, plenty of oxygen should be given to prevent cyanosis. In extreme cases, the operator can inject 2 or 3 mils of the anesthetic solution in order to block a certain nerve branch, injecting the solution very slowly and closely watching his patient during the injection. If the nature of the operation is such that several nerve branches must be blocked which supply various regions, after the first block injection is made, several minutes should elapse, then the blood pressure should be taken a second time, and as often as necessary during the injection of the solution to block the various nerve branches. If, after the first injection, the blood pressure is increased to a dangerous point, then operate upon the region blocked and postpone the other injections to a second sitting. However, if the blood pressure is not greatly increased the operator can proceed cautiously with other injections. The writer does not wish to be understood as saying that it is necessary to take the blood pressure of every patient for block anesthesia or nitrous oxid oxygen anesthesia, but he does wish to impress the reader with the necessity of taking the blood pressure of a patient, especially advanced in years, and of those individuals who have an impairment of the circulatory system. Fig. 569 shows the taking of blood pressure by means of the sphygmomanometer.

The preoperative environment of the patient must always be considered while operating under an anesthetic, be it local or general. The preoperative preparation of the patient is overlooked by many operators, and in so doing they are in many cases inviting trouble, especially with the nervous patient. Operators are too prone to forget that patients who present themselves for operation are not infrequently in a highly nervous state, and if such a condition is not counteracted, it is self-evident the operator will experience considerable difficulty during a block injection, or during the induction stage from nitrous oxid oxygen. The duty and responsibility of the operator does not by any means begin at the dental chair, but as soon as the patient enters the office. The patient should never be allowed to see the hypodermic needle or syringe before the injection is made. The reader is referred to Chapter XXI entitled "General Considerations of Operative Technic; Technic Requirements; Essential Factors Underlying the Successful Injection of the Solution;" also to Chapter XXII entitled "The Patient."

Position of Patient.—The patient, during a block injection, should be placed in a semisupine (see Fig. 570), or a horizontal position. The former position during block injections was suggested by Dr. William L. Shearer. The semisupine or horizontal position of the patient during the injection of a local anesthetic solution is not only important for block anesthesia, but is of great importance during the administration of a general anesthetic. It is more difficult to produce syncope or collapse while the patient is in a horizontal position than when in an upright position. When a patient is placed in the horizontal position the work of the heart is lessened. Faintness or shock is produced by the vasodilatation of the arterioles. The blood sinks to the most dependent parts which are the structures in the region of the abdomen. Depriving the brain of its proper amount of oxygen obtained from the blood produces brain anemia, faintness, syncope, shock and collapse. Therefore, if the patient is placed in a horizontal position before the anesthetic is administered,

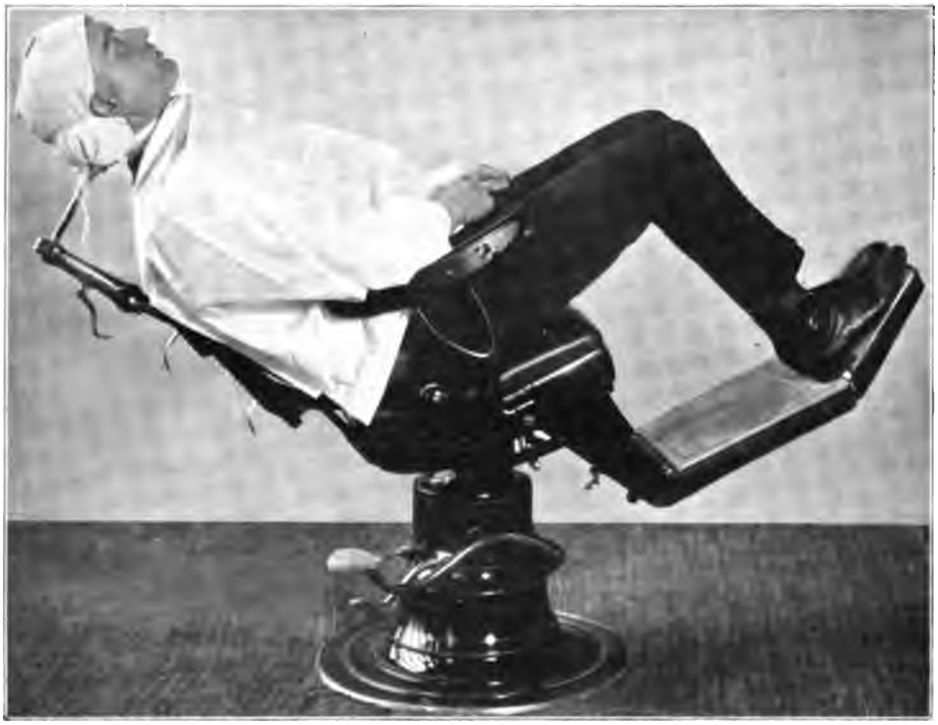

Fig. 570. Position of patient while making the various deep block injections.

it may prevent complications which otherwise might ensue. The patient who has an abnormality of the circulatory system should by all means be placed in a semisupine position, as illustrated in Fig. 570, or better, in a horizontal position. If this simple technic is followed, the operator will experience little or no difficulty during block injections, provided he does not inject an overamount of the solution. The various block injections can be as easily made with the patient placed in the position as illustrated in Fig. 570, as to have him in an upright position, and the possibility of producing faintness or shock is guarded against.

The Slow Injection of the Solution.—The local anesthetic solution should always be injected slowly, and the rate should never exceed one minim per second. *It must be remembered that toxicity caused by a local anesthetic is dependent upon the rapidity with which it enters the circulation. When a large quantity of the solution is injected slowly, it is not apt to be followed by any toxic symptoms, whereas if the same quantity is injected rapidly and should enter the circulation too quickly, toxic symptoms may result. (See page 281 for the five factors which deal with the toxicity of the injecting solution.)*

THE TREATMENT OF FAINTNESS, SYNCOPE, SHOCK AND COLLAPSE

The treatment of these conditions will now be discussed from the standpoint of the oral surgeon and dentist.

Treatment of Faintness.—Many patients are hypersusceptible and become sick very easily. Some are so susceptible that they become sick while having dental operations performed which are accompanied by no pain. The mere sight of instruments, or operating room, tends to lessen their resistance, and many times they will complain of feeling dizzy and have an accelerated pulse. Fainting is the less severe form of circulatory failure, and in most cases it can be counteracted by placing the patient in a horizontal position and by the administration of aromatic spirits of ammonia, or by the application of cold water. *It is a well-known fact that some patients become sick even if no local or general anesthetic has been administered, and the operator should not place the blame upon the anesthetic before knowing positively that it was at fault. Some patients may complain of sickness, dizziness or faintness even before any of the anesthetic solution has been injected.* In other instances fainting has occurred just at the completion of injection, and in many instances, the operator has incorrectly attached the blame to the method or to the local anesthetic solution injected. In some of these cases, if distilled water had been injected, no doubt the patient would have manifested the same symptoms. At this point the writer will cite a practical case.

A physician, a friend of the writer, called upon him to remove a tooth and explained that he had an irregular heart action and that he could not withstand procain or cocain. After examining the circulatory apparatus, all that was revealed was that the patient was nervous. However, this was denied by the patient. To gain his confidence and prove that he was wrong, one mil of sterile Ringer solution was injected, and at the completion of the injection the patient fainted, and upon regaining consciousness exclaimed, "I told you I could not stand a local anesthetic." It was difficult to convince him that sterile Ringer solution had been injected which contained no local anesthetic. The operation was deferred until a later date, at which time 2 mils of procain suprarenin Ringer solution were slowly injected, and again the patient fainted, just as he did following the first injection of the Ringer solution. This is conclusive evidence that the fainting was caused by fear and hypersusceptibility. Many individuals will faint while being vaccinated or during any other slight operative procedure in which no pain is inflicted. This can only be attributed to dread and susceptibility. Many operators have had similar experiences, and they should not be too hasty in condemning the method or the anesthetic solution which they have injected. The treatment of ordinary cases of fainting is very simple.

The Treatment of Mild Cases of Faintness.—Some individuals are hypersusceptible to suprarenin and immediately following an injection may complain of dyspnea, have an accelerated pulse with increase of blood pressure, become anemic and complain of dizziness which in most cases is only transient. The treatment of an ordinary case of fainting caused by dread, apprehension, hypersusceptibility, or from the toxic action of procain and suprarenin, is as follows: The patient is immediately placed in a horizontal position with the head lower than the heart; the collar, neckband and tight clothing are loosened so as not to impair the respiration. As soon as possible, administer 15 to 25 minims of fresh aromatic spirits of ammonia in one-half glass of warm water. In addition, place the bottle containing the aromatic spirits of ammonia in contact with the right nostril, after closing the left nostril with the thumb, and holding the lips together with the fingers which will force the patient to breathe the fumes from the bottle. When the patient regains consciousness, instruct him to breathe deeply, at which time the mouth of the bottle should be in close contact with the right nostril. In this manner each inhalation will fill the patient's lungs with the fumes of the aromatic spirits, which should be continued for several minutes. The ordinary manner of holding the mouth of the bottle to the patient's nose and telling him to breathe is inefficient, inasmuch as he obtains very little of the ammonia vapor. After several inhalations of the ammonia fumes have been taken, it will produce irritation, and the patient will cough on account of the reflex action. In addition to the above, the patient should be given plently of fresh air and kept warm. The application of cold, wet towels or a rubber bag containing ice water applied to the forehead is also beneficial. A cup of black coffee is very stimulating due to the caffein it contains. Five to seven minims of camphorated validol is also a valuable stimulant.

Two methods for preventing an approaching faintness are: first, placing the patient in a horizontal position with head lower than the heart, and, second, tipping the patient forward and forcing his head downward and between his knees, as illustrated in Fig. 571. It is seldom necessary to administer a hypo-

[illegible] dition is transitory. [illegible] the slow injection of [illegible]

Treatment of Mild Cases of Syncope Shock and Collapse Accompanied by Unconsciousness [illegible] the horizontal position

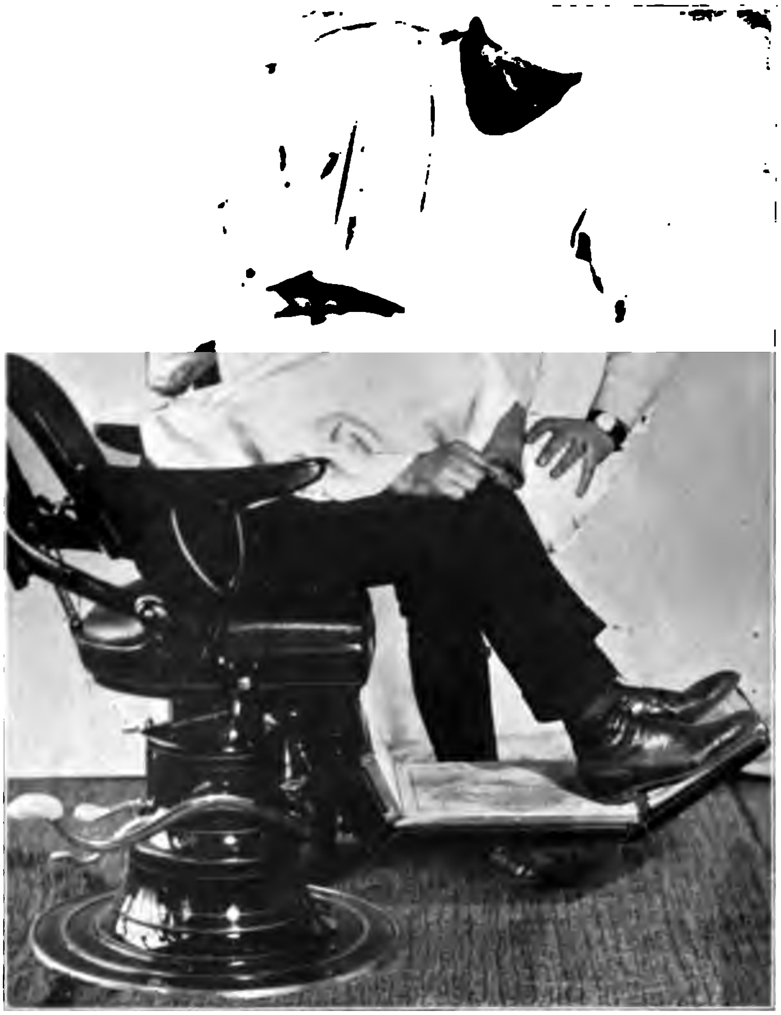

Fig. [illegible]. Position of patient to prevent fainting. Note the patient's head is forced downward and forward between the knees.

with head lower than the heart. The clothing is immediately loosened in order not to restrict the normal respiratory movements. If the patient is unconscious, aromatic spirits of ammonia can not be administered internally, but it can be employed by inhalation as above given. Give the patient plenty of fresh air, apply cold towels or ice bag to forehead, and keep him warm. If the pulse is weak, with a low blood pressure, and the operator thinks the condition of the patient justifies it, he should administer camphorated oil (2 mils) or strychnin (1/60 to 1/30 gr.). (See other stimulants below.)

Treatment of Severe Cases of Shock and Collapse Accompanied by Unconsciousness.—Immediately place the patient in a horizontal position with the head lower than the heart and loosen all clothing which interferes with the respiratory movements. If the respiration has stopped, open the mouth with the wooden wedge as illustrated in Figs. 572 and 573. Following the application of the wooden wedge the patient's jaws are opened with a mouth gag (see Fig. 574), as illustrated in Fig. 575. The mouth is held open by means of a mouth opener, as shown in Fig. 580. The patient's tongue is now drawn forward by means of tongue forceps (see Fig. 576), as illustrated in Fig. 577. If the blood pressure is low, and accompanied by a rapid, weak pulse, the following drugs are employed: camphor and oil; strychnin, caffein, ether by inhalation, and cold packs applied to the patient's face and forehead. If the blood pressure is high, as caused from suprarenin or nitrous oxid, administer amyl nitrite or nitroglycerin, which are vasodilators, followed by cold packs to the head, camphor in oil, strychnin, etc. Forcing oxygen gas into the lungs is highly efficient and can be easily accomplished with a modern nitrous oxid oxygen machine combined with the artificial respiratory movements. In case respiration has stopped, artificial respiration should be employed.

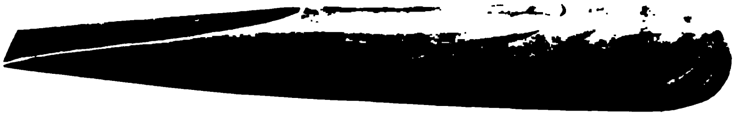

Fig. 572.—Wooden wedge which is employed for opening the patient's mouth in case of syncope or collapse. (Designed by Dr. Geo. B. Winter.)

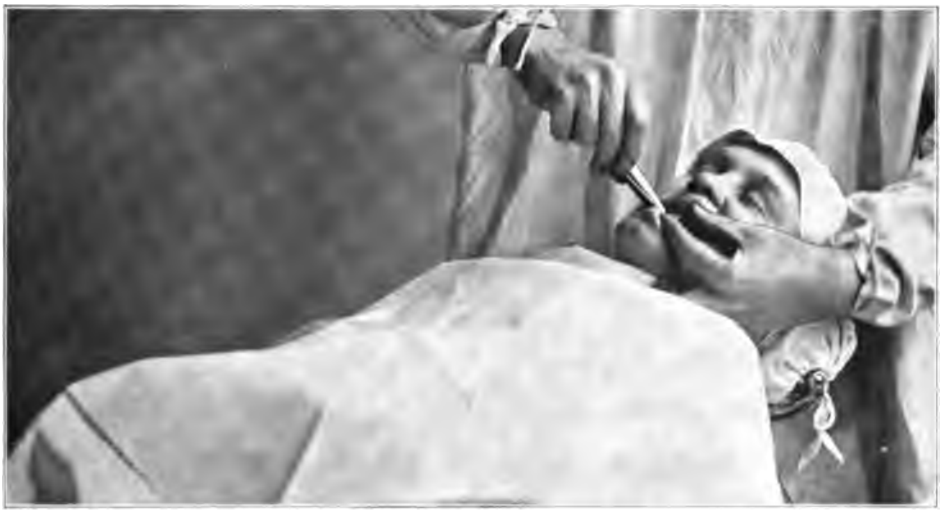

Fig. 573.—Opening the patient's mouth by the use of the wooden wedge.

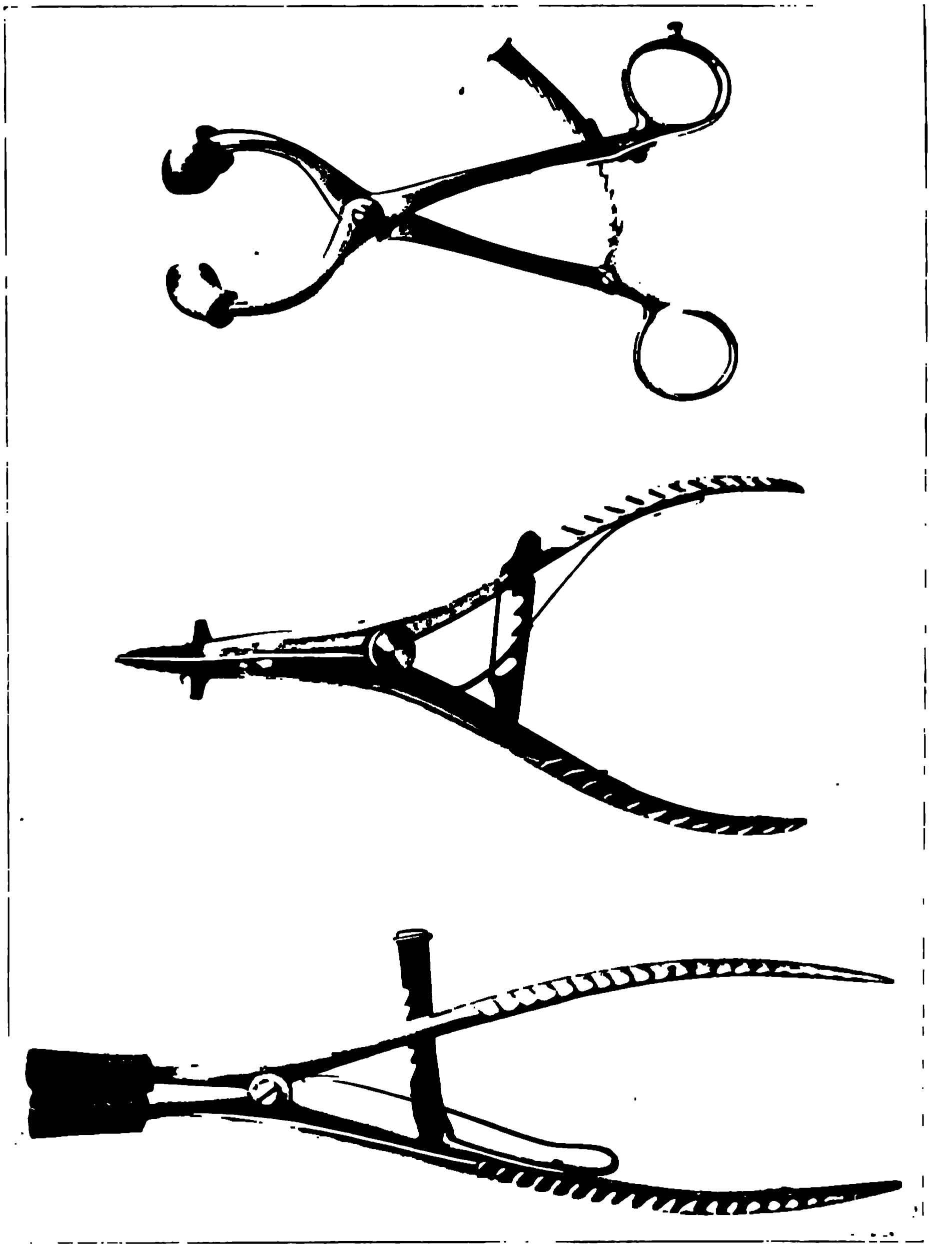

Fig. 574.* Jamison mouth opener (upper). The Bosworth mouth opener (center). The Allen mouth opener (lower).

Artificial Respiration.—There are two methods of artificial respiration. *First*, the Schaefer method, and *second*, the Sylvester method.

The Schaefer Method.—This method is conceded to be the most efficient for producing artificial respiration. The technic is as follows: The patient is placed upon the floor upon his abdomen, as illustrated in Fig. 578. The face is turned to the side and the arms are extended; the mouth open, and the tongue drawn forward so as not to close the respiratory apparatus. The operator occupies a position astride the patient, as shown in Fig. 578. The operator's hands are placed below the kidneys and beneath the ribs, and pressure is exerted inward and upward, which forces the contents of the abdomen upward in contact with the diaphragm, and forces the air out of the lungs. (See Fig. 578.) The inward and upward pressure is now released, as illustrated in Fig. 579. The air entering the mouth expands the lungs, due to atmospheric pressure. This procedure is repeated as long as necessary, starting at twelve times per minute and gradually increasing to the normal respiratory rate, which is eighteen times per minute.

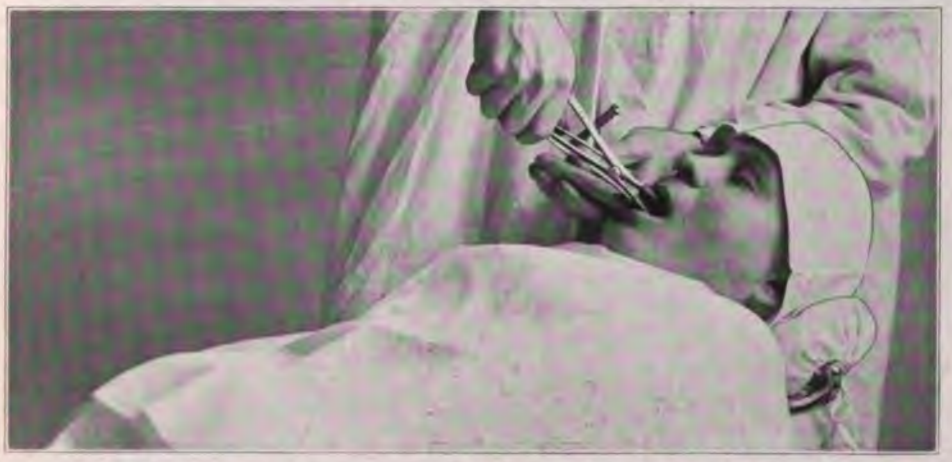

Fig. 575.—Illustrating the use of the mouth opener. (Designed by A. Brom Allen.)

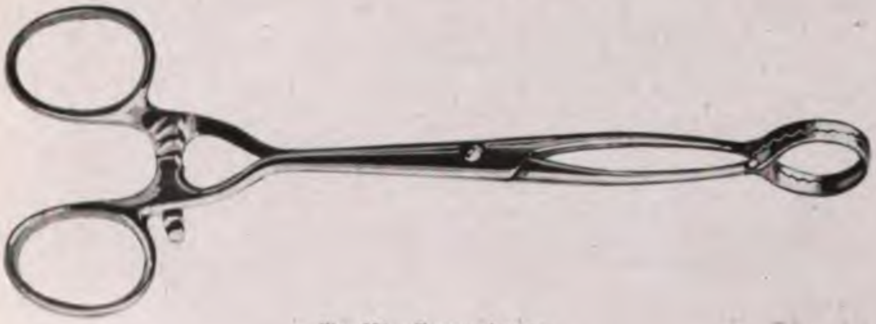

Fig. 576.—Tongue forceps.

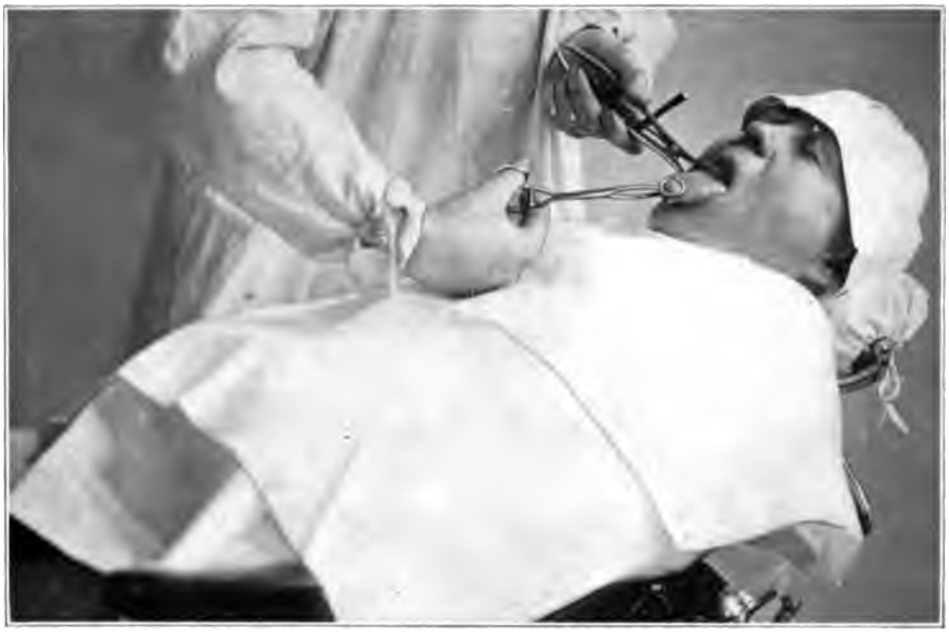

Fig. 577.—Drawing patient's tongue forward by means of the tongue forceps.

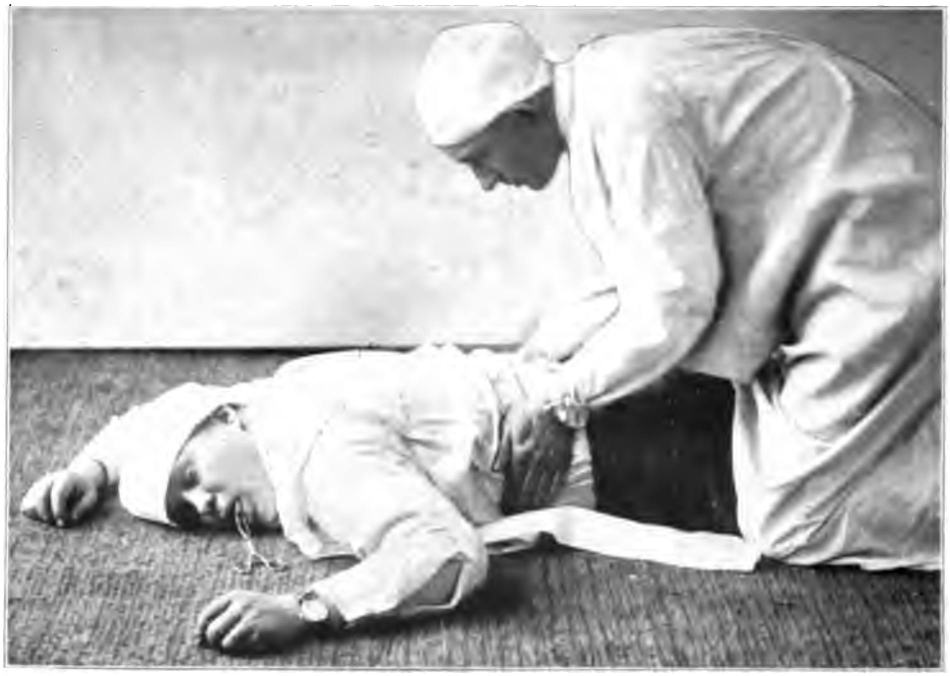

Fig. 578. Illustrating position of patient and operator during first position in producing artificial respiration by the Schaefer method.

The Sylvester Method.—This method can be applied while the patient is in the dental chair. The operator grasps the wrists of the patient and extends the arms backward over the shoulders, as illustrated in Fig. 580. The arms are now folded over the chest, as shown in Fig. 581, and considerable pressure is exerted. This procedure is started at twelve times a minute, gradually increasing it to eighteen times per minute. With the Schaefer method pressure is exerted upon the diaphragm from below which causes a compression of the lungs, and the lungs are expanded by atmospheric pressure. With the Sylvester method the pressure is exerted upon the anterior portion of the chest, and the air from the lungs is expelled by direct pressure upon the chest. The Schaefer method is far superior to that of the Sylvester.

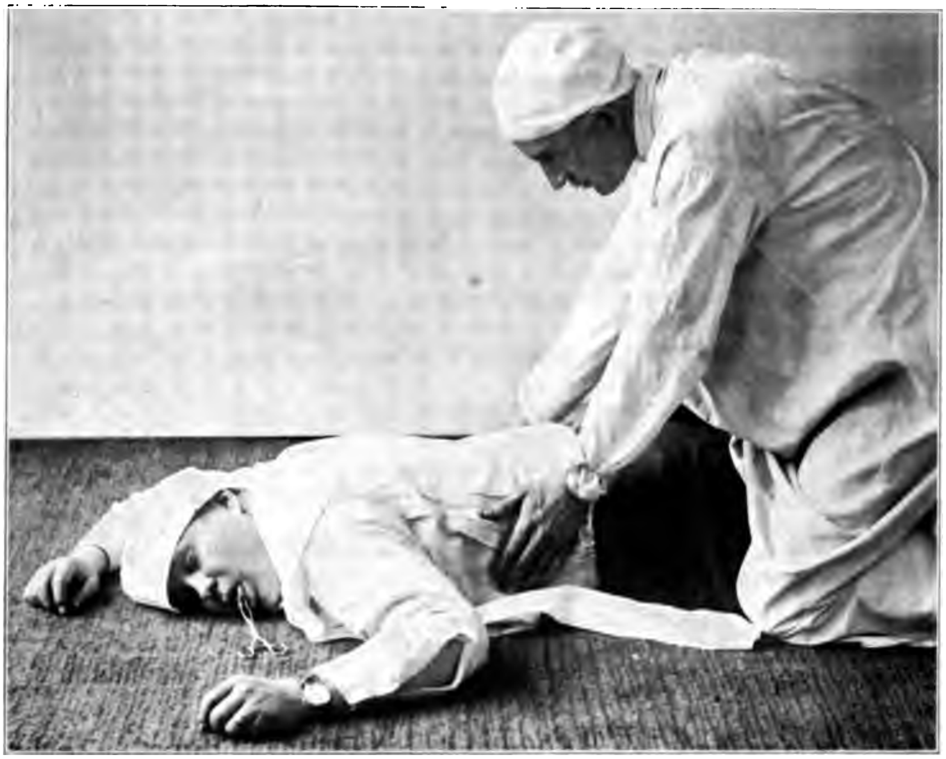

Fig. 579. Illustrating position of patient and operator during second position in producing artificial respiration by the Schaefer method.

Ether as a Stimulant.—Ether is a direct respiratory stimulant and acts as a specific in procain toxicity, and in case the patient is in shock from an overdose of procain, ether should be applied either to gauze or a towel and placed near the patient's nostrils and mouth during artificial respiration. The fumes will be carried into the patient's lungs together with the air. The inhaling of ether fumes is also valuable in treating a patient who has not lost consciousness.

FIG. [illegible] artificial respira- [illegible]

[illegible]

Appliances and Drugs Necessary in the Treatment of Shock and Collapse.—The following drugs and appliances should be on hand at all times in the operating room where local or general anesthesia is employed.

Appliances.—Wooden wedge, mouth opener, mouth prop, tongue forceps, and tongue depressor. (See Figs. 572, 574, 576, 580, and 582.)

Stimulants.—1. Camphorated oil. (Dose 2 to 4 mils.)
2. Strychnin. (Dose 1/60 to 1/30 gr.)
3. Caffein. (Dose 3 to 5 grs.)
4. Nitroglycerin. (Dose 1/150 gr.)

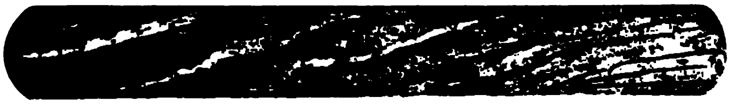

Fig. 582. Wooden tongue depressor.

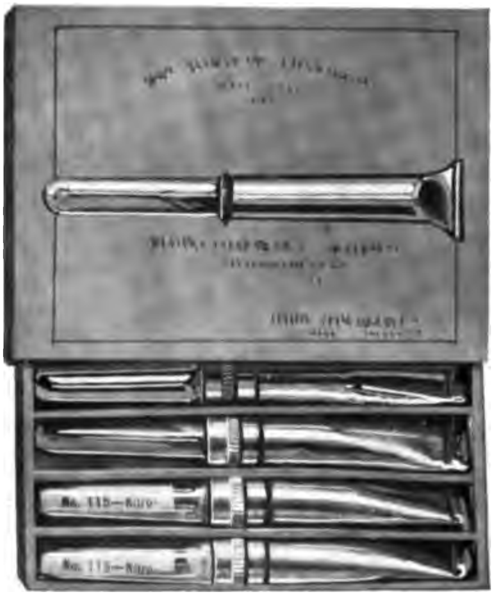

Fig. 583. Illustrating the individual hypodermic units.

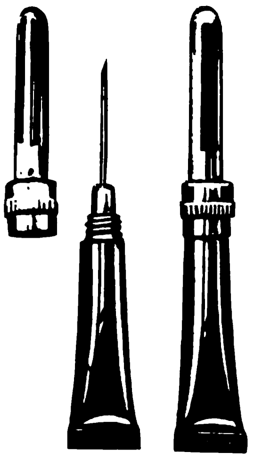

Fig. 584. Illustrating the sealed cap removed from unit preparatory to making hypodermic injection.

5. Sodium nitrite. (Dose 5 to 15 grs.)
6. Potassium nitrite. (Dose 5 to 15 grs.)
7. Morphin and atropin. (Dose, morphin $\frac{1}{8}$ to $\frac{1}{4}$ gr., atropin $\frac{1}{150}$ gr.)
8. Camphorated validol. (5 to 7 minims.)
9. Amyl nitrite. (Pearls, by inhalation.)
10. Ether. (By inhalation.)
11. Black coffee.
12. Oxygen.

The Individual Hypodermic or Unit.—The most convenient method of keeping and administering stimulants hypodermically is by the individual hypodermic, as illustrated in Figs. 583 and 584. These are small individual units containing the desired amount of various drugs. They are convenient, sterile, and contain the correct dosage. An injection with them can be given immediately following syncope or collapse. Various drugs and dosages can be obtained with these units, and this method of administration is superior to the ordinary hypodermic and tablets. (See Fig. 585.)

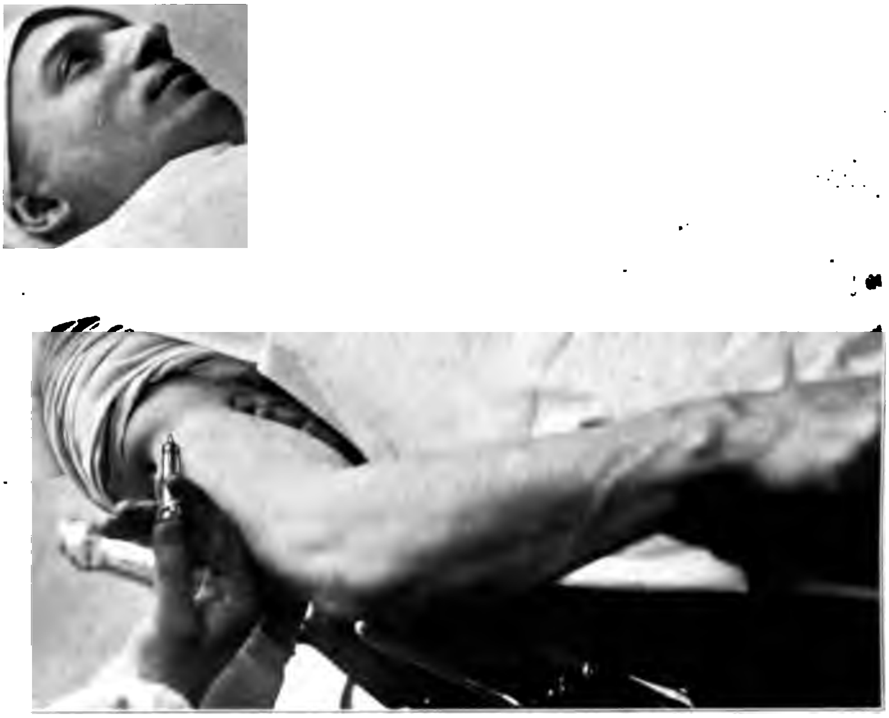

Fig. 585. Making hypodermic injection in region of biceps.

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